1082-F-1 Y3.T25:.55/984

TENNESSEE VALLEY AUTHORITY

ORIGINAL

97

RADIOLOGICAL HEALTH STAFF

ENVIRONMENTAL RADIOACTIVITY LEVELS
BROWNS FERRY NUCLEAR PLANT
ANNUAL REPORT - 1984
TVA/NUC PR/RH

April 1985

I

CONTENTS

List of Tables iii

List of Figures. iv

Introduction 1

Atmospheric Monitoring 11

Terrestrial Monitoring 23

Reservoir Monitoring 43

Quality Control. 55

Data Analysis. 55

Conclusions. 55

LIST OF TABLES

Table 1 - Environmental Radioactivity Sampling Schedule 3
Table 2 - Atmospheric and Terrestrial Monitoring Station Locations - Browns Ferry Nuclear Plant 4
Table 3 - Detection Capabilities for Environmental Sample Analysis 5
Table 4 - Results Obtained in Interlaboratory Comparison Program 7
Table 5 - Maximum Permissible Concentrations for Nonoccupational Exposure 13
Table 6 - Radioactivity in Air Filter 14
Table 7 - Radioactivity in Rainwater 15
Table 8 - Radioactivity in Heavy Particle Fallout 16
Table 9 - Radioactivity in Charcoal Filters 17
Table 10 - Radioactivity in Milk 26
Table 11 - Radioactivity in Vegetation 27
Table 12 - Radioactivity in Soil 28
Table 13 - Radioactivity in Well Water 29
Table 14 - Radioactivity in Public Water Supply 30
Table 15 - Environmental Gamma Radiation Levels 31
Table 16 - Radioactivity in Cabbage 32
Table 17 - Radioactivity in Corn 33
Table 18 - Radioactivity in Peaches 34
Table 19 - Radioactivity in Peas 35
Table 20 - Radioactivity in Potatoes 36
Table 21 - Radioactivity in Poultry 37
Table 22 - Radioactivity in Tomatoes 38
Table 23 - Sampling Schedule - Reservoir Monitoring 45
Table 24 - Radioactivity in Surface Water 46
Table 25 - Radioactivity in White Crappie (Flesh) 47
Table 26 - Radioactivity in Smallmouth Buffalo (Flesh) 48
Table 27 - Radioactivity in Smallmouth Buffalo (Whole) 49
Table 28 - Radioactivity in Sediment 50
Table 29 - Radioactivity in Clam Flesh 51
Table 30 - Radioactivity in Clam Shell 52

LIST OF FIGURES

Figure 1 - Tennessee Valley Region 10

Figure 2 - Atmospheric and Terrestrial Monitoring Network 18

Figure 3 - Local Monitoring Stations 19

Figure 4 - TLD Locations, BFN 20

Figure 5 - Annual Average Gross Beta Activity in Air Filters, Browns Ferry Nuclear Plant 21

Figure 6 - Annual Average Gross Beta Activity in Drinking Water, Browns Ferry Nuclear Plant 39

Figure 7 - Direct Radiation Levels, BFN 40

Figure 8 - Direct Radiation Levels, BFN (4-Quarter Moving Average) . . . 40

Figure 9 - Direct Radiation Levels, WBN 41

Figure 10 - Direct Radiation Levels, WBN (4-Quarter Moving Average) . . . 41

Figure 11 - Reservoir Monitoring Network 53

Figure 12 - Annual Average Gross Beta Activity in Surface Water 54

ENVIRONMENTAL RADIOACTIVITY LEVELS

BROWNS FERRY NUCLEAR PLANT

ANNUAL REPORT

1984

Introduction

The Browns Ferry Nuclear Plant (BFN), operated by the Tennessee Valley Authority, is located on a site owned by TVA containing 840 acres of land in Limestone County, Alabama, bounded on the west and south by Wheeler Reservoir (see figure 1). The site is 10 miles southwest of Athens, Alabama, and 10 miles northwest of Decatur, Alabama. The plant consists of three boiling water reactors; each unit is rated at 3,293 MWt and 1,098 MWe. Unit 1 achieved criticality on August 17, 1973, and began commercial operation on August 1, 1974. Unit 2 began commercial operation on March 1, 1975. However, a fire in the cable trays on March 22, 1975, forced the shutdown of both reactors. Units 1 and 2 resumed operation and Unit 3 began testing in August 1976. Unit 3 began commercial operation in January 1977.

The preoperational environmental radiological monitoring program established a baseline of data on the distribution of natural and manmade radioactivity in the environment near the plant site. However, seasonal, yearly, and random variations in the data were observed. In order to determine the potential increases in environmental radioactivity levels caused by the plant, comparisons were made between data for indicator stations (those near the plant) and control stations (those remote from the plant) in conjunction with comparisons with preoperational data.

Radiological Health (Office of Nuclear Power) and the Office of Natural Resources and Economic Development carried out the sampling program outlined in tables 1 and 23. Sampling locations are shown in figures 2, 3, 4, and 11, and table 2 describes the locations of the atmospheric and terrestrial monitoring stations. All the radiochemical and instrumental analyses were conducted in TVA's Western Area Radiological Laboratory (WARL) located in Muscle Shoals, Alabama. Alpha and beta analyses were performed on Beckman Low Beta II, Beckman Wide Beta II low background proportional counters or a Tennelec LB-5100. Nuclear Data (ND) Model 6700 system, in conjunction with germanium detection systems, were used to analyze the samples for specific gamma-emitting radionuclides. Specific analysis for iodine-131 in charcoal filters is performed using NaI(Tl) well detector systems attached to single channel analyzers. A TVA fabricated beta-gamma coincidence counting system is utilized for the determination of iodine-131 concentrations in milk.

Data were entered in computer storage for processing specific to the analysis conducted. The data obtained by germanium detectors were resolved by the appropriate analyzer software and the software program routine HYPERMET.

The detection capabilities for environmental sample analyses given as the nominal lower limits of detection (LLD) are listed in table 3. All photopeaks found in germanium spectra were identified and quantified. Many of the isotopes identified by germanium spectral analysis are naturally occurring or naturally produced radioisotopes, such as ^{7}Be, ^{40}K, ^{212}Bi, ^{214}Bi, ^{212}Pb, ^{214}Pb, ^{226}Ra, etc. LLDs for radionuclides identified by Ge(Li) analysis were calculated for each analysis and nominal values are listed in table 3B. In the instance where an LLD has not been established, an LLD value of zero was assumed. A notation in a table of "__ values <LLD" for an isotope with no established LLD does not imply a value less than 0; rather it indicates that the isotope was not identified in that specific group of samples. For each sample type, only the radionuclides for which values greater than the LLD were reported are listed in the data tables.

TVA's WARL participates in the Environmental Radioactivity Laboratory Intercomparison Studies Program conducted by EPA-Las Vegas. This program provides periodic cross-checks on samples of the type and radionuclide composition normally analyzed in an environmental radiological monitoring program. Routine sample handling and analysis procedures were employed in the evaluation of these samples. The results received during calendar year 1984 are shown in table 4. The $\pm 3\sigma$ limits based on one measurement were divided by the square root of 3 to correct for triplicate determinations.

Table 1

ENVIRONMENTAL RADIOACTIVITY SAMPLING SCHEDULE

Station Locations	Air Filter	Charcoal Filter	Rain-water	Heavy Particle Fallout	Soil	Vegetation	Milk	River Water	Well Water	Public Water	Aquatic Life and Sediment	Foods
Muscle Shoals	W	W	M	M	A	M				M		
Lawrenceburg	W	W	M	M	A	M						
Rogersville	W	W	M	M	A	M						
Athens	W	W	M	M	A	M						
Decatur	W	W	M	M	A	M				M		
Courtland	W	W	M	M	A	M						
Site 1 (N)	W	W	M	M	A	M						
Site 2 (NNE)	W	W	M	M	A	M						
Site 3 (ENE)	W	W	M	M	A	M						
Site 4 (NNW)	W	W	M	M	A	M						
Site 5 (WSW)	W	W	M	M	A	M						
Farm B						M	W					
Farm S*						M	W		M			
Farm P						M	W					
Farm L						M	W					
Farm E						M						
Farm W						M						
Control Farms						Q	W					A
Onsite Well									M			
Wheeler Dam										M		
Elk River								M				
Tennessee River								M			S	
Champion Paper Co.										W		
Various Local Farms												A

W - Weekly M - Monthly (Every 4 Weeks) Q - Quarterly S - Semiannually A - Annually

*Discontinued operation November 1984

Table 2

ATMOSPHERIC AND TERRESTRIAL MONITORING STATION LOCATIONS
BROWNS FERRY NUCLEAR PLANT

Sample Station	Approximate Distance From Plant	Approximate Direction From Plant
LM-1 BF, North	1.0 Mile (1.6 kilometers)	N
LM-2 BF, North-Northeast	0.9 Mile (1.4 kilometers)	NNE
LM-3 BF, East-Northeast	1.0 Mile (1.4 kilometers)	ENE
LM-4 BF, North-Northwest	1.7 Miles (2.7 kilometers)	NNW
LM-5 BF, West-Southwest	2.5 Miles (4.0 kilometers)	WSW
PM-1 BF, Rogersville, AL	13.8 Miles (22.2 kilometers)	NW
PM-2 BF, Athens, AL	10.9 Miles (17.5 kilometers)	NE
PM-3 BF, Decatur (Trinity), AL	8.2 Miles (13.2 kilometers)	SSE
PM-4 BF, Courtland, AL	10.5 Miles (16.9 kilometers)	WSW
RM-1 BF, Muscle Shoals, AL (Control)	32.0 Miles (51.5 kilometers)	W
RM-2 BF, Lawrenceburg, TN (Control)	40.5 Miles (65.2 kilometers)	NNW
Farm S*	4.75 Miles (7.6 kilometers)	N
Farm B	7.0 Miles (11.3 kilometers)	NW
Farm L	5.0 Miles (7.0 kilometers)	NE
Farm P	8.8 Miles (14.1 kilometers)	E
Farm E	6.1 Miles (9.8 kilometers)	NE
Farm W	6.9 Miles (11.0 kilometers)	NE
Farm N (Control)	27.0 Miles (43.4 kilometers)	NW
Farm J (Control)	40.0 Miles (64.4 kilometers)	NNW
Farm C (Control)	32.0 Miles (51.5 kilometers)	N
Farm Ca (Control)	32.0 Miles (51.5 kilometers)	W
Farm Cb (Control	22.5 Miles (36.2 kilometers	E
Farm M (Control)	22.5 Miles (36.2 kilometers)	ENE

*Discontinued operations November 1984

Table 3

DETECTION CAPABILITIES FOR ENVIRONMENTAL SAMPLE ANALYSIS

A. Specific Analyses

NOMINAL LOWER LIMIT OF DETECTION (LLD)*

	Air Particulates pCi/m^3	Charcoal pCi/m^3	Fallout mCi/Km^2	Water pCi/l	Vegegation and Grain pCi/g, Dry	Soil and Sediment pCi/g, Dry	Fish Clam Flesh, Plankton, pCi/g, Dry	Clam Shells pCi/g, Dry	Foods, Meat, Poultry, pCi/Kgm, Wet	Milk pCi/l
Gross α	0.005			2.0	0.05	0.35	0.1	0.7		
Gross β	0.01		0.05	2.3	0.20	0.70	0.1	0.7	25	
^{3}H				330						
^{131}I		0.02								0.05
^{89}Sr	0.005			10	0.25	1.5	0.5	5.0	40	10
^{90}Sr	0.001			2	0.05	0.3	0.1	1.0	8	2

*All LLD values for isotopic separations are calculated by the method developed by Pasternack and Harley as described in HASL-300. Factors such as sample size, decay time, chemical yield, and counting efficiency may vary for a given sample; these variations may change the LLD value for the given sample. The assumption is made that all samples are analyzed within one week of the collection date. Conversion factors: 1 pCi - 3.7×10^{-2} Bq; 1 mCi = $x.7 \times 10^{7}$ Bq.

Table 3

DETECTION CAPABILITIES FOR ENVIRONMENTAL SAMPLE ANALYSIS

B. Gamma Analyses

NOMINAL LOWER LIMIT OF DETECTION (LLD)

	Air particulates pCi/m³		Water and milk pCi/l		Vegetation and grain pCi/g, dry		Soil and sediment pCi/g, dry		Fish pCi/g, dry		Clam flesh and plankton pCi/g, dry		Clam shells pCi/g, dry		Foods,(tomatoes potatoes, etc.) pCi/Kg, wet		Meat and poultry pCi/Kg, wet	
	NaI*	Ge(Li)**	NaI	Ge(Li)	NaI	Ge(Li)	NaI	Ge(Li)	NaI	Ge(Li)	NaI	Ge(Li)	NaI	Ge(Li)	NaI	Ge(Li)	NaI	Ge(Li)
^{141,144}Ce	0.03		38		0.65		0.35		0.35				0.35		38		90	
^{144}Ce		0.02		33		0.22		0.06		0.06	0.35			0.06		33		40
^{51}Cr	0.07	0.03	60	44	1.10	0.47	0.60	0.10	0.60	0.10	0.56		0.60	0.10	60	44	200	90
^{131}I	0.01	0.01	15	8	0.35	0.09	0.20	0.02	0.20	0.02	0.07		0.20	0.02	15	8	50	20
^{103,106}Ru	0.04		40		0.65		0.45		0.45				0.45		40		150	
^{106}Ru		0.03		40		0.51		0.11		0.11	0.74			0.11		40		90
^{134}Cs	0.01	0.02	10	26	0.20	0.33	0.12	0.08	0.12	0.08	0.48		0.12	0.08	10	26	40	50
^{137}Cs	0.01	0.01	10	5	0.20	0.06	0.12	0.02	0.12	0.02	0.08		0.12	0.02	10	5	40	15
^{95}Zr-Nb	0.01		10		0.20		0.12		0.12				0.12		10		40	
^{95}Zr		0.01		10		0.11		0.03		0.03	0.15			0.03		10		20
^{95}Nb		0.01		5		0.05		0.01		0.01	0.07			0.01		5		15
^{58}Co	0.02	0.01	15	5	0.23	0.05	0.20	0.01	0.20	0.01	0.07		0.20	0.01	15	5	55	15
^{54}Mn	0.02	0.01	10	5	0.20	0.05	0.15	0.01	0.15	0.01	0.08		0.15	0.01	10	5	40	15
^{65}Zn	0.02	0.01	15	9	0.25	0.11	0.23	0.02	0.23	0.02	0.17		0.23	0.02	15	9	70	20
^{60}Co	0.01	0.01	10	5	0.17	0.06	0.11	0.01	0.11	0.01	0.08		0.11	0.01	10	5	30	15
^{40}K	0.10		150		2.50		0.90		0.90				0.90		150		400	
^{140}Ba-La	0.02		15		0.68		0.15		0.15				0.15		15		50	
^{140}Ba		0.02		25		0.34		0.07		0.07	0.30			0.07		25		50
^{140}La		0.01		7		0.08		0.02		0.02	0.10			0.02		7		15

*The NaI(Tl) LLD values are calculated by the method developed by Pasternack and Harley as described in HASL-300 and Nucl. Instr. Methods 91, 533-40 (1971). These LLD values are expected to vary depending on the activities of the components in the samples. These figures do not represent the LLD values achievable on a given sample. Water is counted in a 3.5-l Marinelli beaker. Vegetation, fish, soil, and sediment are counted in a 1-pint container as dry weight. The average dry weight is 120 grams for vegetation and 400-500 grams for soil sediment and fish. Meat and poultry are counted in a 1-pint container as dry weight, then corrected to wet weight using an average moisture content of 70%. Average dry weight is 250 grams. Air particulates are counted in a well crystal. The counting system consists of a multichannel analyzer and either a 4" x 4" solid or 4" x 5" well NaI(Tl) crystal. The counting time is 4000 seconds. All calculations are performed by the least-squares computer program ALPHA-M. The assumption is made that all samples are analyzed within one week of the collection date.

**The Ge(Li) LLD values are calculated by the method developed by Pasternack and Harley as described in HASL-300. These LLD values are expected to vary depending on the activities of the components in the samples. These figures do not represent the LLD values achievable on given samples. Water is counted in either a 0.5-L or 3.5-L Marinelli beaker. Solid samples, such as soil, sediment, and clam shells, are counted in a 0.5-L Marinelli beaker as dry weight. The average dry weight is 400-500 grams. Air filters and very small volume samples are counted in petri dishes centered on the detector endcap. The counting system consists of a ND-6620 multichannel analyzer and germanium detector having an efficiency of 20 percent. The counting time is normally 4-15 hours. All spectral analysis is performed using the software program HYPERMET. The assumption is made that all samples are analyzed within one week of the collection date.
Conversion factor: 1 pCi = x.7 x 10^{-1} Bq.

TABLE 4

RESULTS OBTAINED IN INTERLABORATORY COMPARISON PROGRAM

A. Air Filter (pCi/Filter)

Date	Gross Alpha		Gross Beta		Strontium-90		Cesium-137	
	EPA value (±3σ)	TVA Avg.	EPA value (±3σ)	TVA Avg.	EPA value (±3σ)	TVA Avg.	EPA value (±3σ)	TVA Avg.
11/83	19±9	<1[a]	50±9	40[a]	15±3	16	21±9	20
3/84	15±9	18	51±9	60	21±3	20	11±9	10
8/84	17±9	17	51±9	60	18±3	N/A[b]	15±9	15

B. Tritum in Urine (pCi/1)

Date	EPA value (±3σ)	TVA Avg.
2/84	2383±608	2466
11/84	2012±598	2047

a. Sample fouled in preparation. Procedure modified to prevent recurrence.
b. Lost in analysis.

TABLE 4 (Continued)

RESULTS OBTAINED IN INTERLABORATORY COMPARISON PROGRAM

C. Radiochemical Analysis of Water (pCi/1)

Date	Gross Alpha		Gross Beta		Strontium-89		Strontium-90		Tritium		Iodine-131	
	EPA value (±3σ)	TVA Avg.	EPA value (±3σ)	TVA Avg.	EPA value (±3σ)	TVA Avg.	EPA value (±3σ)	TVA Avg.	EPA value (±3σ)	TVA Avg.	EPA value (±3σ)	TVA Avg.
1/84	10±9	10	12±9	15	36±9	39	24±3	23				
3/84	5±9	6	20±9	20								
4/84									3508±630	3580	6±0.8	6
5/84	3±9	4	6±9	6	25±9	32	5±3	5				
6/84									3081±622	2770		
7/84	6±9	6	13±9	16								
8/84									2817±617	2607	34±10	36
9/84	5±9	5	16±9	12	34±9	41	19±3	18				
10/84									2810±617	2517		
10/84[c]	14±9	11	64±9	60	11±9	12	12±3	13				
11/84	7±9	8	20±9	22								
12/84									3182±624	3400	36±10	33

D. Gamma-Spectral Analysis of Water (pCi/1)

Date	Chromium-51		Cobalt-60		Zinc-65		Ruthenium-106		Cesium-134		Cesium-137	
	EPA value (±3σ)	TVA Avg.	EPA value (±3σ)	TVA Avg.	EPA value (±3σ)	TVA Avg.	EPA value (±3σ)	TVA Avg.	EPA value (±3σ)	TVA Avg.	EPA value (±3σ)	TVA Avg.
2/84	40±9	<44	10±9	11	50±9	50	61±9	53	31±9	29	16±9	15
6/84	66±9	72	31±9	32	63±9	66	29±9	<40	47±9	44	37±9	37
10/84	40±9	43	20±9	22	147±9	151	47±9	48	31±9	29	24±9	26
10/84[c]			14±9	17					2±9	<5	14±9	16

c. Laboratory performance evaluation study

TABLE 4 (Continued)

RESULTS OBTAINED IN INTERLABORATORY COMPARISON PROGRAM

E. Foods (pCi/kg, Wet Weight)

Date	Strontium-89		Strontium-90		Iodine-131		Cesium-137		Potassium-40[d]	
	EPA value (±3σ)	TVA Avg.	EPA value (±3σ)	TVA Avg.	EPA value (±3σ)	TVA Avg.	EPA value (±3σ)	TVA Avg.	EPA value (±3σ)	TVA Avg.
1/84	34±9	40	20±3	19	20±10	20	20±9	21	2730±236	2670
7/84	25±9	N/A[e]	20±3	N/A[e]	39±10	40	25±9	26	2605±226	2624

F. Milk (pCi/l)

Date	Strontium-89		Strontium-90		Iodine-131		Cesium-137		Potassium-40[f]	
	EPA value (±3σ)	TVA Avg.	EPA value (±3σ)	TVA Avg.	EPA value (±3σ)	TVA Avg.	EPA value (±3σ)	TVA Avg.	EPA value (±3σ)	TVA Avg.
3/84					6±0.9	6				
6/84	25±9	24	17±3	18	43±10	39	35±9	34	1496±130	1483
10/84	22±9	26	16±3	15	42±10	40	32±9	30	1517±132	1563

d. Values reported as mg K/kg.
e. Lost in sample preparation.
f. Values reported as mg K/l.

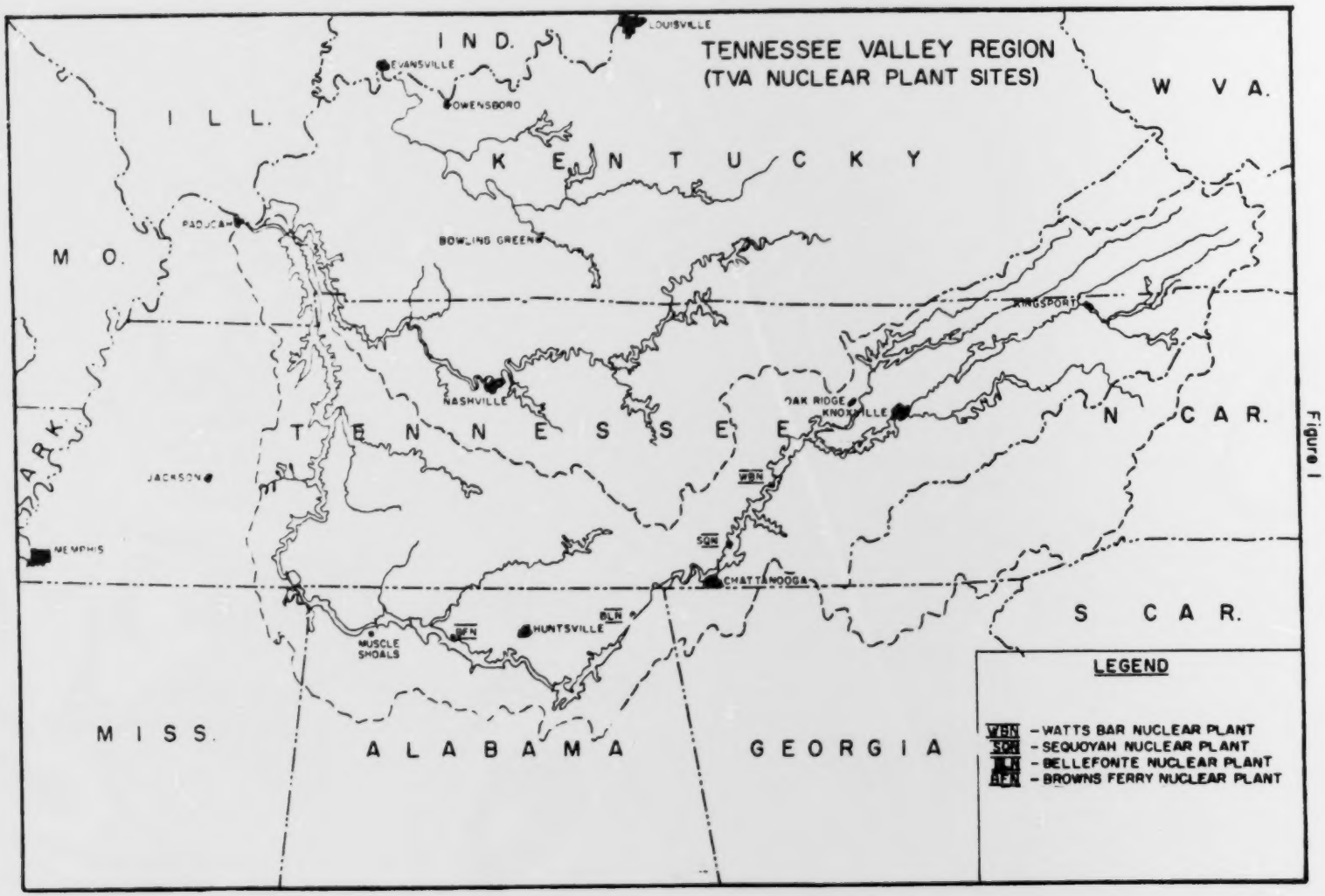

TENNESSEE VALLEY REGION
(TVA NUCLEAR PLANT SITES)
LOUISVILLE
IND.
EVANSVILLE
OWENSBORO
ILL.
W VA.
KENTUCKY
PADUCAH
BOWLING GREEN
MO.
KINGSPORT
NASHVILLE
OAK RIDGE
KNOXVILLE
TENNESSEE
N CAR.
ARK.
JACKSON
WBN
MEMPHIS
SQN
CHATTANOOGA
S CAR.
BLN
HUNTSVILLE
BFN
MUSCLE SHOALS
MISS.
ALABAMA
GEORGIA
LEGEND
WBN - WATTS BAR NUCLEAR PLANT
SQN - SEQUOYAH NUCLEAR PLANT
BLN - BELLEFONTE NUCLEAR PLANT
BFN - BROWNS FERRY NUCLEAR PLANT

Figure 1

Atmospheric Monitoring

The atmospheric monitoring network is divided into three groups. Four local air monitors are located on or adjacent to the plant site in the general areas of greatest wind frequency. One additional station is located at the point of maximum predicted off-site concentration of radionuclides based on preoperational meteorological data (see figures 3 and 4). Four perimeter air monitors are located at distances out to 10 miles from the plant, and two remote air monitors are located at distances out to 45 miles. These monitoring stations are shown in figure 2. The remote monitors are used as control or baseline stations. At each monitor, air is continuously pulled through a Hollingsworth and Voss LB5211 glass fiber particulate filter at a flow rate of 3 ft^3/min. In series with, but downstream of, the particulate filter is a charcoal filter used to collect iodine. Each monitor has a collection tray and storage container to obtain rainwater on a continuous basis and a horizontal platform that is covered with gummed acetate to catch and hold heavy particle fallout. Thermoluminescent dosimeters are used to record gamma radiation levels at each remote and perimeter station.

Each of the local air monitors is fitted with a GM tube that continuously scans the particulate filter. The disintegration rate of the atmospheric radioactivity is continuously recorded at each station and radiotelemetered into the plant.

Air Filters

Air filters are collected weekly and analyzed for gross beta activity. No analyses are performed until three days after sample collection. The samples are composited monthly for analysis of specific gamma-emitting radionuclides and quarterly for ^{89}Sr and ^{90}Sr analysis. The results are combined for each station to obtain an annual average. These data are presented in table 6. During this reporting period, three samples were not obtained because of equipment malfunction. One sample was damaged beyond use.

The annual averages of the gross beta activity in the air particulate filters at the indicator stations (local and perimeter monitors) and at the control stations (remote monitors) for the years 1968-1984 are presented in figure 5. Increased levels due to fallout from atmospheric nuclear weapons testing are evident, especially in 1969, 1970, 1971, 1977, 1978, and 1981. These patterns are consistent with data from monitoring programs conducted by TVA at nonoperating nuclear power plant construction sites. Table 5 presents the maximum permissible concentrations (MPC) specified in 10 CFR 20 for nonoccupational exposure.

Rainwater

Rainwater is collected monthly and a 3.5-liter sample analyzed for specific gamma-emitting radioisotopes and tritium. The results are shown in table 7. During this reporting period, one sample from each station (11) was not available due to extended drought conditions.

Fallout

The gummed acetate that is used to collect heavy particle fallout is changed monthly. The samples are ashed and counted for gross beta activity. The results are given in table 8. During this reporting period, one sample was inadvertently destroyed and could not be analyzed.

Charcoal Filters

Charcoal filters are collected and analyzed for radioiodine. The filter is counted in a single channel analyzer system. The results are shown in table 9. During this reporting period, three samples were not taken because of equipment malfunction or filter damage, two samples were destroyed during filter change, and two samples were lost during analysis.

Table 5

MAXIMUM PERMISSIBLE CONCENTRATIONS

FOR NONOCCUPATIONAL EXPOSURE

	MPC	
	In Water pCi/l*	In Air pCi/m^3*
Alpha	30	
Nonvolatile beta	3,000	100
Tritium	3,000,000	200,000
^{137}Cs	20,000	500
$^{103,106}Ru$	10,000	200
^{144}Ce	10,000	200
^{95}Zr-^{95}Nb	60,000	1,000
^{140}Ba-^{140}La	20,000	1,000
^{131}I	300	100
^{65}Zn	100,000	2,000
^{54}Mn	100,000	1,000
^{60}Co	30,000	300
^{89}Sr	3,000	300
^{90}Sr	300	30
^{51}Cr	2,000,000	80,000
^{134}Cs	9,000	400
^{58}Co	90,000	2,000

*1 pCi = 3.7×10^{-2} Bq.

TABLE 6

RADIOACTIVITY IN AIR FILTER

PCI/M(3) - 0.037 BQ/M(3)

NAME OF FACILITY BROWNS FERRY — DOCKET NO. 50-259,260,296
LOCATION OF FACILITY LIMESTONE ALABAMA — REPORTING PERIOD 1986

TYPE AND TOTAL NUMBER OF ANALYSIS PERFORMED	LOWER LIMIT OF DETECTION[a] (LLD)	ALL INDICATOR LOCATIONS MEAN (F)[b] RANGE[b]	LOCATION WITH HIGHEST ANNUAL MEAN NAME DISTANCE AND DIRECTION	MEAN (F)[b] RANGE[b]	CONTROL LOCATIONS MEAN (F)[b] RANGE[b]	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
GROSS ALPHA	0.005				0.01(1/ 50)	
50					0.01- 0.01	
GROSS BETA	0.010	C.02(437/ 466)	ATHENS, AL	0.02(50/ 52)	0.02(96/ 102)	
568		C.01- 0.04	10.9 MILES NE	C.01- 0.04	0.01- C.04	
GAMMA (GELI)						
143						
K-40	NOT ESTAB	C.02(58/ 117)	LM2 BF NORTH	0.02(5/ 13)	0.01(12/ 26)	
		C.00- 0.04	0.9 MILE NNE	0.01- 0.04	0.01- C.02	
BI-214	0.020	C.02(1/ 117)	LM1 BF NORTHWEST	0.02(1/ 13)	0.02(1/ 26)	
		C.02- 0.02	1.0 MILE N	0.02- 0.02	0.02- C.02	
BI-212	NOT ESTAB	0.01(1/ 117)	ROGERSVILLE, AL	0.01(1/ 13)	26 VALUES <LLD	
		C.01- 0.01	13.8 MILES NW	0.01- 0.01		
PB-214	0.020	0.02(2/ 117)	LM1 BF NORTHWEST	0.02(1/ 13)	0.02(1/ 26)	
		C.02- 0.02	1.0 MILE N	0.02- 0.02	0.02- C.02	
PB-212	NOT ESTAB	C.00(21/ 117)	LM5 BF DAVIS F	0.00(2/ 13)	0.00(6/ 26)	
		C.00- 0.00	2.5 MILES WSW	0.00- C.00	0.00- C.00	
BE-7	0.050	C.06(85/ 117)	ATHENS, AL	0.07(10/ 13)	0.07(18/ 26)	
		C.05- 0.11	10.9 MILES NE	0.05- C.10	0.05- C.12	
TL-208	NOT ESTAB	C.00(19/ 117)	COURTLAND, AL	0.00(1/ 13)	0.00(6/ 26)	
		C.00- 0.00	10.5 MILES WSW	0.00- 0.00	0.00- C.00	
AC-228	NOT ESTAB	C.00(8/ 117)	LM3 BF NORTHEAST	0.00(1/ 13)	0.01(2/ 26)	
		C.00- 0.00	1.0 MILE ENE	0.00- 0.00	0.00- 0.01	
PA-234M	NOT ESTAB	C.18(2/ 117)	ROGERSVILLE, AL	0.19(1/ 13)	26 VALUES <LLD	
		C.17- 0.19	13.8 MILES NW	0.19- C.19		
SR 89	0.005	36 VALUES <LLD			8 VALUES <LLD	
44		ANALYSIS PERFORMED				
SR 90	0.001	36 VALUES <LLD			8 VALUES <LLD	
44		ANALYSIS PERFORMED				

a. Nominal Lower Limit of Detection (LLD) as described in Table 3.
b. Mean and range based upon detectable measurements only. Fraction of detectable measurements at specified locations is indicated in parentheses (F).

BLANK PAGE

BLANK PAGE

BLANK PAGE

TABLE 7

RADIOACTIVITY IN RAINWATER

PCI/L - 0.037 BQ/L

NAME OF FACILITY BROWNS FERRY — DOCKET NO. 50-259,260,296

LOCATION OF FACILITY LIMESTONE ALABAMA — REPORTING PERIOD 1984

TYPE AND TOTAL NUMBER OF ANALYSIS PERFORMED	LOWER LIMIT OF DETECTION[a] (LLD)	ALL INDICATOR LOCATIONS MEAN (F)[b] RANGE[b]	LOCATION WITH HIGHEST ANNUAL MEAN NAME DISTANCE AND DIRECTION	MEAN (F)[b] RANGE[b]	CONTROL LOCATIONS MEAN (F)[b] RANGE[b]	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
GAMMA (GELI) 132						
K-40	NOT ESTAB	22.33(9/ 108)	LM1 BF NORTHWEST	38.51(1/ 12)	27.22(2/ 24)	
		6.57- 45.38	1.0 MILE N	38.51- 38.51	21.45- 33.00	
BI-214	NOT ESTAB	5.93(52/ 108)	COURTLAND, AL	7.56(11/ 12)	6.45(14/ 24)	
		0.13- 28.18	10.5 MILES WSW	0.77- 28.18	0.20- 28.88	
PB-214	NOT ESTAB	4.08(29/ 108)	COURTLAND, AL	6.20(8/ 12)	9.29(5/ 24)	
		0.07- 20.11	10.5 MILES WSW	1.46- 20.11	3.92- 24.73	
PB-212	NOT ESTAB	1.60(35/ 108)	ATHENS, AL	2.46(5/ 12)	1.80(5/ 24)	
		0.18- 4.62	10.9 MILES NE	1.20- 4.62	0.79- 3.64	
BE-7	NOT ESTAB	49.37(28/ 108)	ROGERSVILLE, AL	58.88(4/ 12)	45.59(8/ 24)	
		29.26- 99.30	13.8 MILES NW	42.48- 99.30	38.65- 71.09	
TRITIUM 132	330.000	108 VALUES <LLD ANALYSIS PERFORMED			24 VALUES <LLD	

a. Nominal Lower Limit of Detection (LLD) as described in Table 3.

b. Mean and range based upon detectable measurements only. Fraction of detectable measurements at specified locations is indicated in parentheses (F).

15

TABLE 8

RADIOACTIVITY IN HEAVY PARTICLE FALLOUT

MCI/KM(2) - 37000000.00 BQ/KM(2)

NAME OF FACILITY BROWNS FERRY — DOCKET NO. 50-259,260,296

LOCATION OF FACILITY LIMESTONE ALABAMA — REPORTING PERIOD 1984

TYPE AND TOTAL NUMBER OF ANALYSIS PERFORMED	LOWER LIMIT OF DETECTION[a] (LLD)	ALL INDICATOR LOCATIONS MEAN (F)[b] RANGE[b]	LOCATION WITH HIGHEST ANNUAL MEAN NAME DISTANCE AND DIRECTION	MEAN (F)[b] RANGE[b]	CONTROL LOCATIONS MEAN (F)[b] RANGE[b]	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
GROSS BETA	0.050	0.22(114/ 116)	LM4 BF TRAILER P	0.46(12/ 12)	0.16(25/ 26)	
142		0.06- 1.25	1.7 MILES NNW	0.21- 1.25	0.06- 0.46	

a. Nominal Lower Limit of Detection (LLD) as described in Table 3.
b. Mean and range based upon detectable measurements only. Fraction of detectable measurements at specified locations is indicated in parentheses (F).

TABLE 9

RADIOACTIVITY IN CHARCOAL FILTERS

PCI/M(3) - 0.037 BQ/M(3)

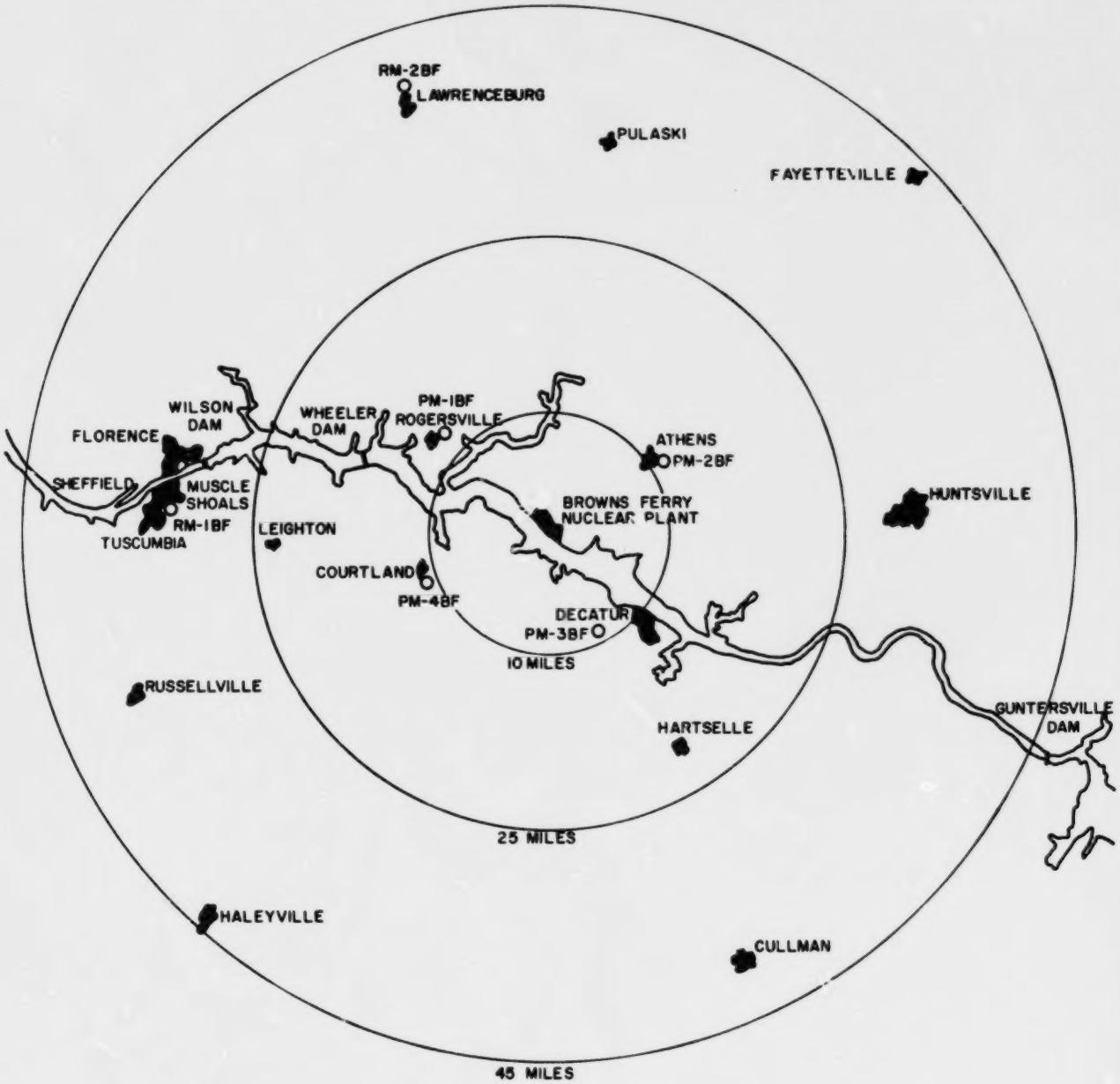
NAME OF FACILITY BROWNS FERRY — DOCKET NO. 50-259,260,296
LOCATION OF FACILITY LIMESTONE ALABAMA — REPORTING PERIOD 1984

TYPE AND TOTAL NUMBER OF ANALYSIS PERFORMED	LOWER LIMIT OF DETECTION [a] (LLD)	ALL INDICATOR LOCATIONS MEAN (F)[b] RANGE[b]	LOCATION WITH HIGHEST ANNUAL MEAN NAME DISTANCE AND DIRECTION	MEAN (F)[b] RANGE[b]	CONTROL LOCATIONS MEAN (F)[b] RANGE[b]	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
IODINE-131	0.020	0.02(27/ 463)	LM2 SF NORTH	0.03(2/ 52)	0.02(10/ 102)	
565		0.02- 0.04	0.9 MILE NNE	0.02- 0.03	0.02- 0.03	

a. Nominal Lower Limit of Detection (LLD) as described in Table 3.
b. Mean and range based upon detectable measurements only. Fraction of detectable measurements at specified locations is indicated in parentheses (F).

Figure 2

ATMOSPHERIC AND TERRESTRIAL MONITORING NETWORK



O—ENVIRONMENTAL MONITORING STATION

NOTE: THE FOLLOWING SAMPLES ARE COLLECTED FROM EACH STATION:

AIR PARTICULATES	RAINWATER
RADIOIODINE	SOIL
HEAVY PARTICLE FALLOUT	

Figure 3

LOCAL MONITORING STATIONS

BROWNS FERRY NUCLEAR PLANT

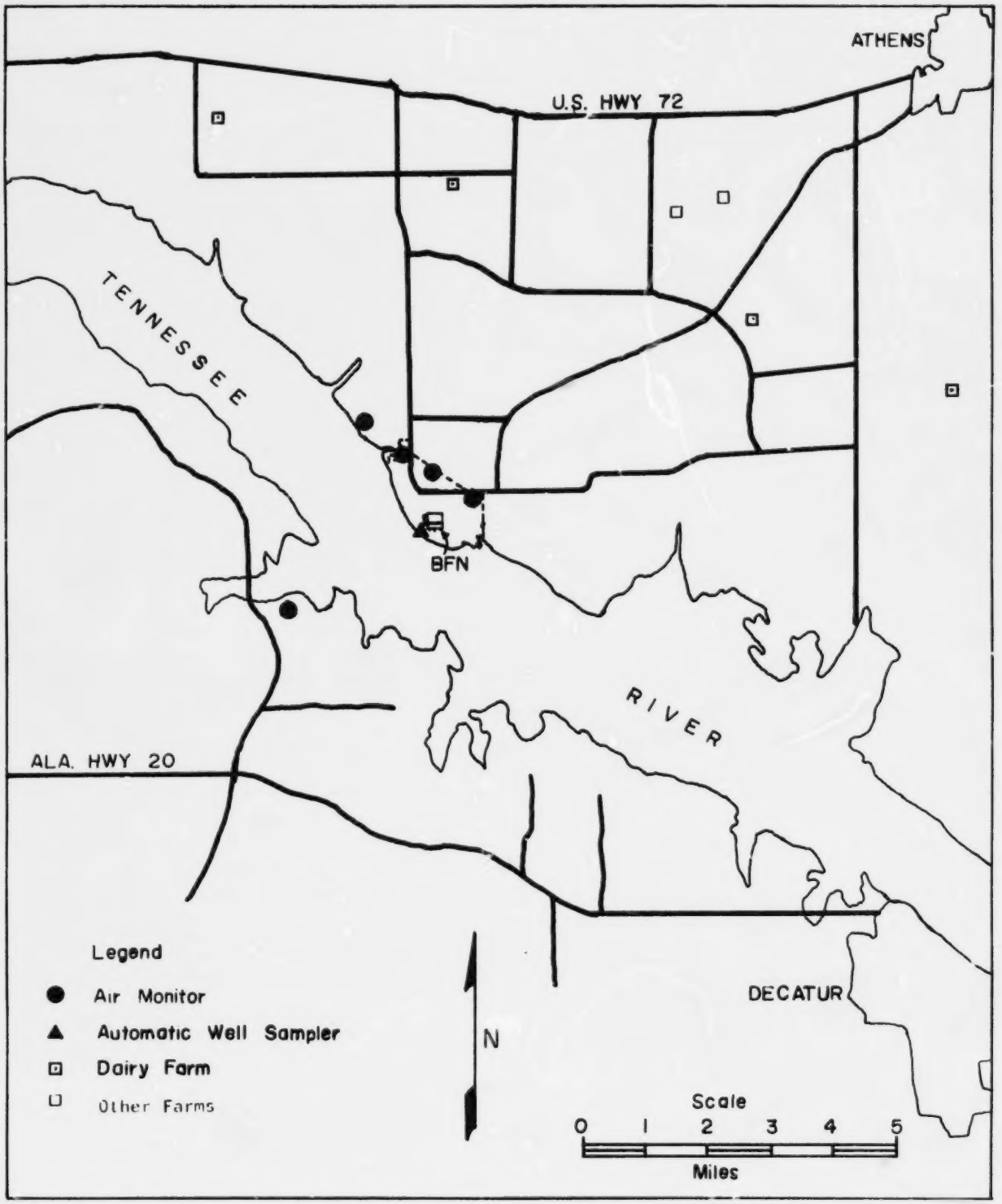


Figure 4

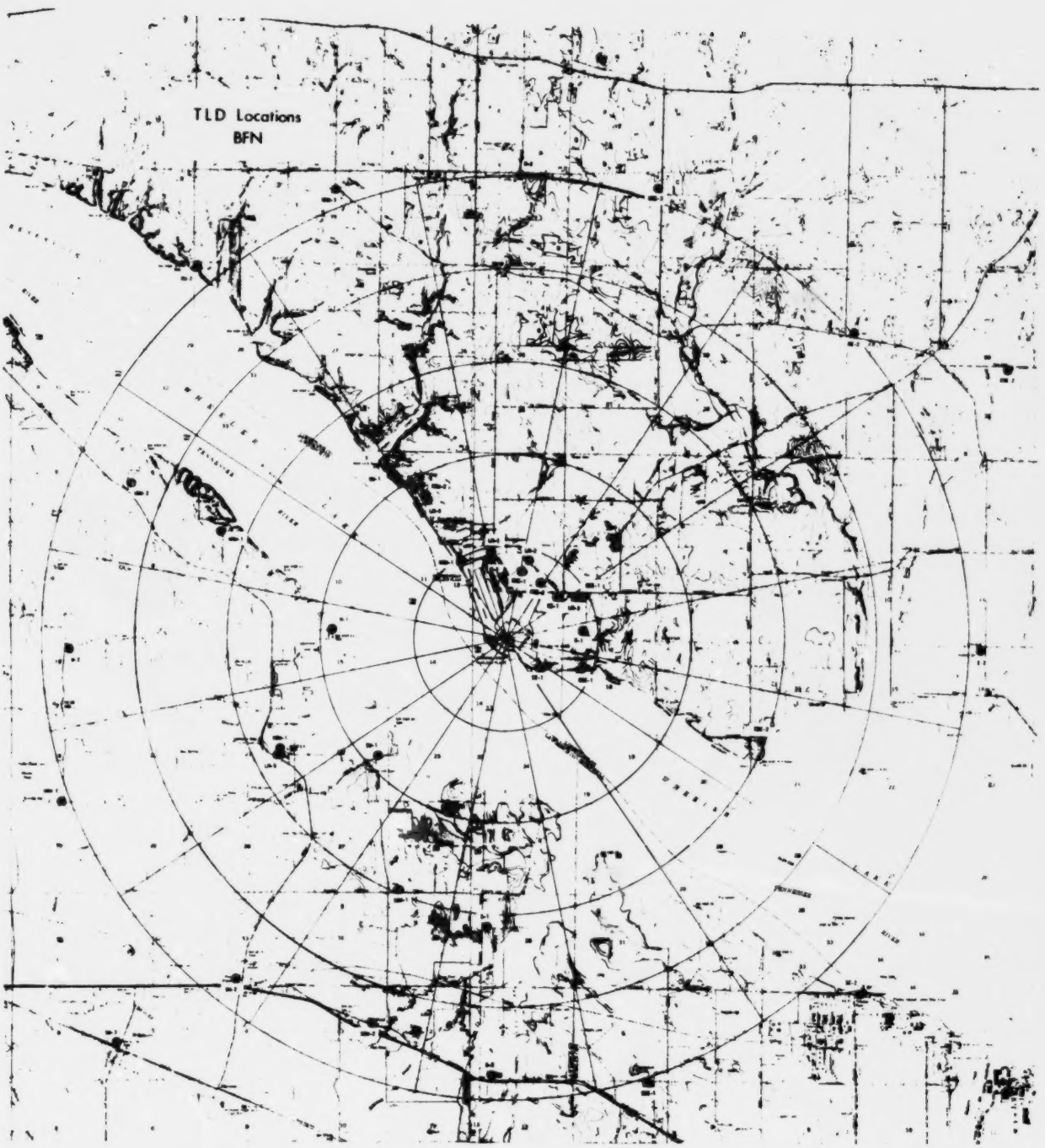
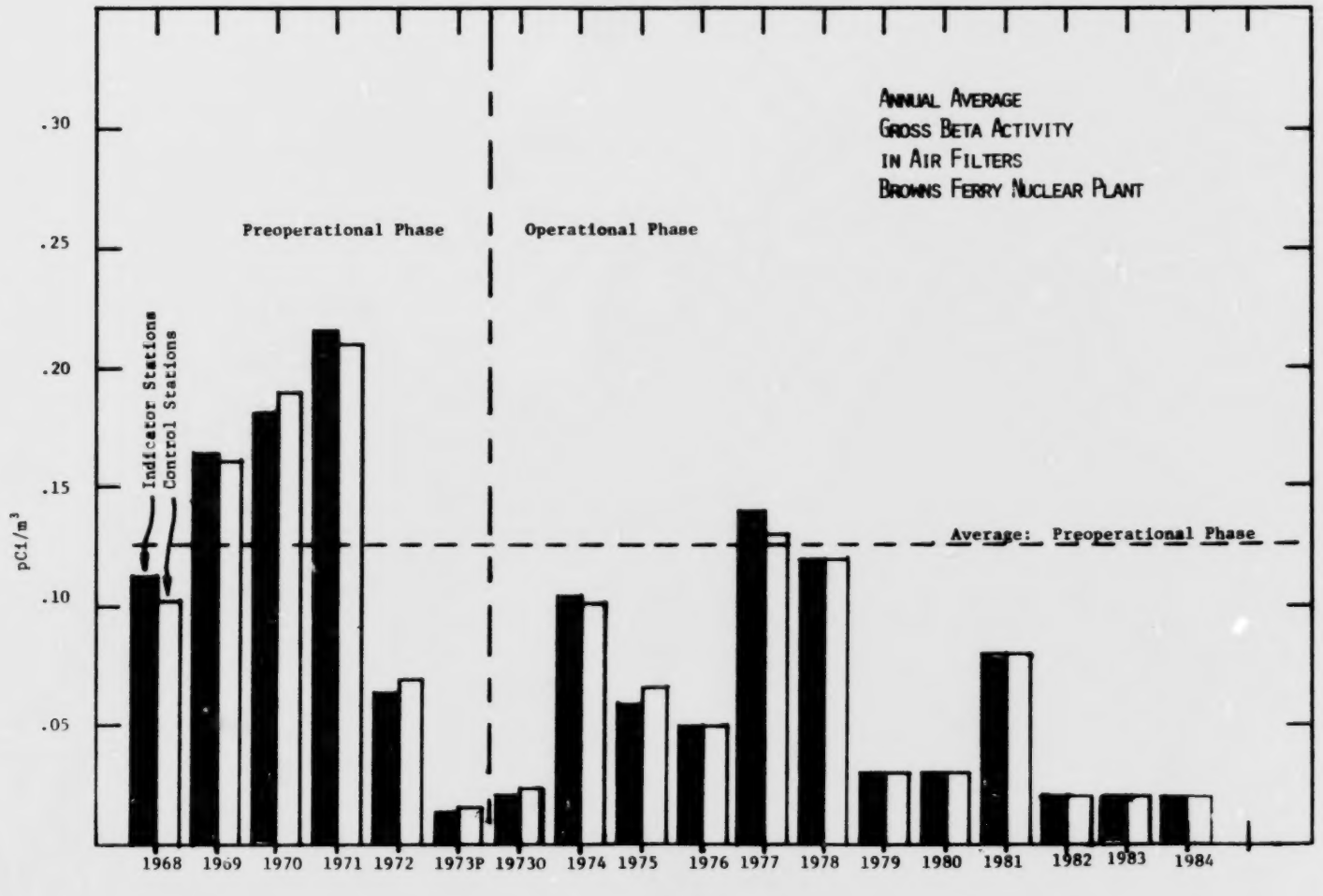


Figure 5


Annual Average
Gross Beta Activity
in Air Filters
Browns Ferry Nuclear Plant
Preoperational Phase
Operational Phase
Indicator Stations
Control Stations
Average: Preoperational Phase
pCi/m³
.30
.25
.20
.15
.10
.05
1968
1969
1970
1971
1972
1973P
1973O
1974
1975
1976
1977
1978
1979
1980
1981
1982
1983
1984

21

BLANK PAGE

Terrestrial Monitoring

Terrestrial monitoring is accomplished by collecting environmental media within the general area of the plant for indicator locations, and at remote locations for controls. These media sampled include milk, vegetation, soil, ground water, drinking water, and food crops. In addition, environmental gamma radiation levels are determined by strategic placement of thermoluminescent dosimeters. Twice each year a land use survey is conducted to determine milk producing animal census and location.

Land Use Survey

The land use surveys were conducted in June and September of 1984. Milk animal census and locations were unchanged from the previous survey. Projected doses to individuals in the area were not significantly different from those calculated for 1983. It was determined that the current environmental monitoring program is adequate.

Milk

Milk is collected from four farms within a 10-mile radius of the plant (see figure 3), and from at least one of six control farms. During this reporting period, one indicator dairy farm disposed of all milk animals and ceased operations (November 1984). Information provided by the latest land use survey indicated that there are no replacement dairies in the vicinity of the plant. In compliance with plant technical specifications, a Special Report was submitted to the Nuclear Regulatory Commission on December 13, 1984.

Raw milk samples are collected from indicator and control farms, and are analyzed weekly for iodine-131 and monthly for gamma-emitting isotopes and radiostrontium. Analytical results are summarized in table 10. During the 1984 reporting period, 13 samples were not available for collection. Four samples spoiled and could not be analyzed.

Vegetation

Vegetation is sampled monthly at six indicator farms (four dairies and two farms with one milk-producing animal), and at each air monitoring station. Quarterly vegetation samples are collected at four control farms. The monthly samples are analyzed for iodine-131 and gamma-emitting isotopes with analysis for radiostrontium performed on the last monthly sample of each quarter. Samples collected quarterly are analyzed for gamma-emitting isotopes. Table 11 summarizes analytical results. During this reporting period, one monthly sample was not collected because of severe weather conditions, one sample spoiled before a gamma scan could be performed, and one set of samples for March were "lost" prior to strontium analysis because of analytical difficulties. Laboratory procedures were revised to prevent reoccurrence.

Soil

Soil samples are collected annually near each monitoring station to provide an indication of long-term buildup of radioactivity in the environment. An auger or "cookie cutter" type sampler is used to obtain samples of the top two inches (5 cm) of soil. These samples are analyzed for gamma-emitting radionuclides, strontium-89, and strontium-90. The results are given in table 12.

Ground Water

An automatic sequential-type sampling device collects groundwater from a well downgradient from BFN. A composite sample from this well is analyzed for gamma-emitting radionuclides monthly and composited quarterly for determination of tritium. A grab sample is also taken monthly from a control well upgradient from the plant. The results of the analysis of well water are shown in table 13.

Drinking Water

Potable water supplies taken from the Tennessee River in the vicinity of BFN are sampled and analyzed for gross beta and gamma-emitting radionuclides, and composited quarterly for tritium, ^{89}Sr, and ^{90}Sr analyses. The first potable water supply downstream from the plant is equipped with an automatic sampler with samples collected and analyzed weekly. The sampler is located on the water intake structure and takes the sample from the river as the raw water is drawn into the water treatment facility. Two additional supplies downstream and one public water supply upstream are sampled by taking monthly grab samples of treated water at user points. Table 14 indicates the results from the analysis of drinking water samples. During this reporting period, gross beta of one of the weekly samples was not determined because of insufficient sample size caused by the malfunction of automatic sampling equipment.

Figure 6 shows the trends in gross beta activity in drinking water from 1968 through 1984. The annual average level from the raw water samples tends to run slightly higher than the average for treated water samples; however, the levels are consistent with the activities reported in surface water samples taken upstream from BFN (figure 12) and in samples taken from the Tennessee River in preoperational monitoring programs conducted by TVA at other sites.

Environmental Gamma Radiation Levels

Bulb-type Victoreen manganese-activated calcium fluoride (Ca_2F: Mn) thermoluminescent dosimeters (TLDs) are placed at sixteen stations around the plant near the site boundary, at the perimeter and remote air monitors, and at nineteen additional stations out to approximately five miles from the site to determine the gamma exposure rates at these locations. The dosimeters, located inside energy compensating shields to correct for energy dependence, are placed at approximately one meter above the ground, with three TLDs at each station. They are

annealed and read with a Victoreen model 2810 TLD reader. The values are corrected for gamma response, self-irradiation, and fading, with individual gamma response calibrations and self-irradiation factors determined for each TLD. The TLDs are exchanged every three months. The quarterly gamma radiation levels determined from these TLDs are given in table 15, which indicates that average levels at onsite stations are approximately 2-4 mR/quarter higher than levels at offsite stations. This is consistent with levels reported at TVA's nonoperating nuclear power plant construction sites where the average radiation levels onsite are generally 2-6 mR/quarter higher than levels offsite. The causes of these differences have not been completely isolated; however, it is postulated that the differences are probably attributable to combinations of influences, such as natural variations in environmental radiation levels, earth moving activities onsite, the mass of concrete employed in the construction of the plant, and other undetermined influences.

Figure 7 compares plots of the data from the onsite or site boundary stations with those from the offsite stations over the period from 1976 through 1984. To reduce the variations present in the data sets, a four-quarter moving average was constructed for each set. Figure 8 presents a trend plot of the direct radiation levels as defined by the moving averages. The data follow the same general trend as the raw data, but the curves are smoothed considerably.

Prior to 1976 measurements were made with less sensitive dosimeters, and consequently the levels reported in the preoperational phase of the monitoring program are up to 2 times the levels reported herein. Those data are not included in this report. Therefore, for comparison purposes, figures 9 and 10 depict the environmental gamma radiation levels measured during the construction of TVA's Watts Bar Nuclear Plant to the present. Note that the data follow a similar pattern to the BFN data and that, as discussed above, the levels reported at onsite stations are similarly higher than the levels at offsite stations.

Food Products

Food products raised in the vicinity of BFN and at control locations are sampled as they become available during the growing season, and analyzed for gross beta activity and for gamma-emitting radionuclides. During this sampling period, samples of cabbage, corn, peaches, peas, potatoes, poultry, and tomatoes were collected and analyzed for specific gamma-emitting radionuclides. The results are given in tables 16 through 22.

TABLE 10

RADIOACTIVITY IN MILK

PCI/L - 0.037 BQ/L

NAME OF FACILITY BROWNS FERRY — DOCKET NO. 50-259,260,296
LOCATION OF FACILITY LIMESTONE ALABAMA — REPORTING PERIOD 1984

TYPE AND TOTAL NUMBER OF ANALYSIS PERFORMED	LOWER LIMIT OF DETECTION[a] (LLD)	ALL INDICATOR LOCATIONS MEAN (F)[b] RANGE[b]	LOCATION WITH HIGHEST ANNUAL MEAN NAME DISTANCE AND DIRECTION	MEAN (F)[b] RANGE[b]	CONTROL LOCATIONS MEAN (F)[b] RANGE[b]	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
IODINE-131	0.500	195 VALUES <LLD			302 VALUES <LLD	
497		ANALYSIS PERFORMED				
GAMMA (GELI)						
124						
CS-137	5.000	7.55(7/ 48)	PAGE FARM	8.20(4/ 12)	5.67(1/ 76)	
		5.15- 11.01	8.75 MILES E	5.15- 11.01	5.67- 5.67	
K-40	NOT ESTAB	1271.95(48/ 48)	SMITH FARM	1337.93(10/ 10)	1270.05(76/ 76)	
		881.59- 1787.99	4.75 MILES N	1155.58- 1787.99	789.79- 1839.06	
BI-214	NOT ESTAB	11.65(27/ 48)	PAGE FARM	19.15(10/ 12)	7.43(55/ 76)	
		0.47- 126.67	8.75 MILES E	1.11- 126.67	0.36- 19.47	
PB-214	NOT ESTAB	19.05(13/ 48)	PAGE FARM	39.86(4/ 12)	6.76(38/ 76)	
		0.00- 140.10	8.75 MILES E	0.00- 140.10	0.72- 25.94	
PB-212	NOT ESTAB	2.21(10/ 48)	PAGE FARM	2.53(2/ 12)	1.59(22/ 76)	
		0.80- 3.80	8.75 MILES E	2.31- 2.74	0.02- 4.51	
TL-208	NOT ESTAB	0.81(11/ 48)	SMITH FARM	1.22(5/ 10)	1.33(20/ 76)	
		0.22- 3.31	4.75 MILES N	0.37- 3.31	0.03- 2.89	
AC-228	NOT ESTAB	2.21(5/ 48)	LOONEY FARM	13.36(1/ 13)	5.99(7/ 76)	
		2.53- 13.36	5.75 MILES ENE	13.36- 13.36	0.72- 25.22	
SR 89	10.000	46 VALUES <LLD			76 VALUES <LLD	
122		ANALYSIS PERFORMED				
SR 90	2.000	4.26(41/ 46)	SMITH FARM	5.10(10/ 10)	3.88(71/ 76)	
122		2.23- 7.29	4.75 MILES N	3.49- 7.29	2.07- 8.79	

a. Nominal Lower Limit of Detection (LLD) as described in Table 3.
b. Mean and range based upon detectable measurements only. Fraction of detectable measurements at specified locations is indicated in parentheses (F).

TABLE 11

RADIOACTIVITY IN VEGETATION

PCI/G - C.037 BQ/G (DRY WEIGHT)

NAME OF FACILITY BROWNS FERRY — DOCKET NO. 50-259,260,296
LOCATION OF FACILITY LIMESTONE ALABAMA — REPORTING PERIOD 1984

TYPE AND TOTAL NUMBER OF ANALYSIS PERFORMED	LOWER LIMIT OF DETECTION[a] (LLD)	ALL INDICATOR LOCATIONS MEAN (F)[b] RANGE[b]	LOCATION WITH HIGHEST ANNUAL MEAN NAME DISTANCE AND DIRECTION	MEAN (F)[b] RANGE[b]	CONTROL LOCATIONS MEAN (F)[b] RANGE[b]	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
GROSS ALPHA	0.050	C.05(1/ 1)	SMITH FARM	0.05(1/ 1)		
1		C.05- 0.05	4.75 MILES N	0.05- 0.05		
GROSS BETA	0.200	7.94(1/ 1)	SMITH FARM	7.94(1/ 1)		
1		7.94- 7.94	4.75 MILES N	7.94- 7.94		
IODINE-131	NOT ESTAB	C.00(161/ 194)	LM1 BF NORTHWEST	0.00(13/ 13)	0.00(19/ 26)	
220		0.00- 0.01	1.C MILE N	0.00- 0.01	0.00- 0.01	
GAMMA (GELI)						
235						
CO-60	0.060	C.14(1/ 193)	LM1 BF NORTHWEST	0.14(1/ 13)	42 VALUES <LLD	
		0.14- 0.14	1.C MILE N	0.14- 0.14		
CS-137	0.060	C.08(11/ 193)	SMITH FARM	0.15(1/ 13)	0.12(5/ 42)	
		0.06- 0.15	4.75 MILES N	0.15- 0.15	0.07- 0.25	
K-40	NOT ESTAB	10.75(193/ 193)	LM2 BF NORTH	14.35(13/ 13)	13.72(42/ 42)	
		0.46- 40.10	0.9 MILE NNE	1.25- 34.03	0.82- 39.54	
BI-214	0.100	0.17(57/ 193)	ATHENS, AL	0.25(1/ 13)	0.19(14/ 42)	
		C.10- 0.43	10.9 MILES NE	0.25- 0.25	0.11- 0.38	
BI-212	NOT ESTAB	C.27(10/ 193)	WISER FARM	0.37(1/ 13)	0.37(3/ 42)	
		0.06- 0.38	6.9 MILES NE	0.37- 0.37	0.25- 0.48	
PB-214	NOT ESTAB	0.08(167/ 193)	EVANS FARM	0.11(13/ 13)	0.10(35/ 42)	
		C.00- 0.40	6.1 MILES NE	0.C1- 0.20	0.00- 0.42	
PB-212	NOT ESTAB	0.04(136/ 193)	LM4 BF TRAILER P	0.C8(12/ 13)	0.06(25/ 42)	
		C.00- 0.27	1.7 MILES NNW	0.C2- 0.16	0.00- 0.27	
RA-223	NOT ESTAB	C.12(1/ 193)	LM5 BF DAVIS F	0.12(1/ 13)	42 VALUES <LLD	
		C.12- 0.12	2.5 MILES WSW	0.12- 0.12		
BE-7	NOT ESTAB	5.88(192/ 193)	ROGERSVILLE, AL	9.71(12/ 12)	6.53(42/ 42)	
		C.21- 25.72	13.8 MILES NW	1.23- 25.72	0.88- 17.23	
TL-208	NOT ESTAB	0.02(114/ 193)	LM3 BF NORTHEAST	0.C4(6/ 13)	0.02(21/ 42)	
		C.00- 0.10	1.C MILE ENE	0.C0- 0.10	0.00- C.10	
AC-228	NOT ESTAB	C.11(111/ 193)	ATHENS, AL	0.31(4/ 13)	0.11(18/ 42)	
		C.00- 1.15	10.9 MILES NE	0.C0- 1.15	0.00- C.33	
PA-234M	NOT ESTAB	3.64(4/ 193)	LM1 BF NORTHWEST	4.96(1/ 13)	2.03(1/ 42)	
		2.78- 4.96	1.C MILE N	4.96- 4.96	2.03- 2.03	
SR 89	0.250	C.48(5/ 46)	LM4 BF TRAILER P	0.80(1/ 3)	6 VALUES <LLD	
52		C.29- 0.80	1.7 MILES NNW	0.80- 0.80		
SR 90	0.050	C.26(45/ 46)	ROGERSVILLE, AL	0.75(3/ 3)	0.46(6/ 6)	
52		C.05- 1.05	13.8 MILES NW	0.63- 0.86	0.26- C.91	

a. Nominal Lower Limit of Detection (LLD) as described in Table 3.
b. Mean and range based upon detectable measurements only. Fraction of detectable measurements at specified locations is indicated in parentheses (F).

27

TABLE 12

RADIOACTIVITY IN SOIL

PCI/G - C.037 BQ/G (DRY WEIGHT)

NAME OF FACILITY BROWNS FERRY — DOCKET NO. 50-259,260,296
LOCATION OF FACILITY LIMESTONE ALABAMA — REPORTING PERIOD 1984

TYPE AND TOTAL NUMBER OF ANALYSIS PERFORMED	LOWER LIMIT OF DETECTION [a] (LLD)	ALL INDICATOR LOCATIONS MEAN (F) [b] RANGE [b]	LOCATION WITH HIGHEST ANNUAL MEAN NAME DISTANCE AND DIRECTION	MEAN (F) [b]	RANGE [b]	CONTROL LOCATIONS MEAN (F) [b] RANGE [b]	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
GAMMA (GELI) 11							
CS-134	0.080	C.16(1/ 9)	LM1 BF NORTHWEST	0.16(1/ 1)		2 VALUES <LLD	
		C.16- 0.16	1.C MILE N	0.16- 0.16			
CS-137	0.020	C.39(9/ 9)	LM5 BF DAVIS F	1.03(1/ 1)		0.51(2/ 2)	
		C.06- 1.03	2.5 MILES WSW	1.03- 1.03		0.26- 0.76	
K-40	0.250	5.28(9/ 9)	LM4 BF TRAILER P	7.29(1/ 1)		4.63(2/ 2)	
		3.32- 7.29	1.7 MILES NNW	7.29- 7.29		4.15- 5.11	
BI-214	0.050	1.00(9/ 9)	LM1 BF NORTHWEST	1.30(1/ 1)		1.06(2/ 2)	
		C.61- 1.30	1.C MILE N	1.30- 1.30		0.90- 1.21	
BI-212	0.100	1.24(9/ 9)	LM1 BF NORTHWEST	1.89(1/ 1)		1.30(2/ 2)	
		C.75- 1.89	1.C MILE N	1.89- 1.89		1.25- 1.35	
PB-214	0.050	1.10(9/ 9)	LM1 BF NORTHWEST	1.47(1/ 1)		1.13(2/ 2)	
		C.68- 1.47	1.C MILE N	1.47- 1.47		0.98- 1.28	
PB-212	NOT ESTAB	1.08(9/ 9)	LM1 BF NORTHWEST	1.60(1/ 1)		1.16(2/ 2)	
		C.57- 1.60	1.C MILE N	1.60- 1.60		1.15- 1.17	
RA-226	0.050	1.00(9/ 9)	LM1 BF NORTHWEST	1.30(1/ 1)		1.06(2/ 2)	
		C.61- 1.30	1.C MILE N	1.30- 1.30		0.90- 1.21	
RA-223	NOT ESTAB	C.35(4/ 9)	ATHENS, AL	0.43(1/ 1)		0.29(1/ 2)	
		C.28- 0.43	10.9 MILES NE	0.43- 0.43		0.29- 0.29	
RA-224	NOT ESTAB	1.09(6/ 9)	DECATUR, AL	1.47(1/ 1)		2 VALUES <LLD	
		C.67- 1.47	8.2 MILES SSE	1.47- 1.47			
BE-7	0.160	9 VALUES <LLD				0.19(1/ 2)	
						0.19- 0.19	
TL-208	0.020	C.38(9/ 9)	LM1 BF NORTHWEST	0.53(1/ 1)		0.42(2/ 2)	
		C.20- 0.53	1.C MILE N	0.53- 0.53		0.42- 0.42	
AC-228	0.060	1.13(9/ 9)	LM1 BF NORTHWEST	1.68(1/ 1)		1.18(2/ 2)	
		C.60- 1.68	1.C MILE N	1.68- 1.68		1.15- 1.22	
PA-234M	NOT ESTAB	2.34(5/ 9)	LM1 BF NORTHWEST	3.64(1/ 1)		2.19(1/ 2)	
		1.70- 3.64	1.C MILE N	3.64- 3.64		2.19- 2.19	
SR 89	1.500	9 VALUES <LLD				2 VALUES <LLD	
11		ANALYSIS PERFORMED					
SR 90	0.300	9 VALUES <LLD				0.34(1/ 2)	
11						0.34- 0.34	

a. Nominal Lower Limit of Detection (LLD) as described in Table 3.
b. Mean and range based upon detectable measurements only. Fraction of detectable measurements at specified locations is indicated in parentheses (F).

TABLE 13

RADIOACTIVITY IN WELL WATER

PCI/L - 0.037 BQ/L

NAME OF FACILITY BROWNS FERRY — DOCKET NO. 50-259,260,296

LOCATION OF FACILITY LIMESTONE ALABAMA — REPORTING PERIOD 1984

TYPE AND TOTAL NUMBER OF ANALYSIS PERFORMED	LOWER LIMIT OF DETECTION [a]	ALL INDICATOR LOCATIONS MEAN (F) [b] RANGE [b]	LOCATION WITH HIGHEST ANNUAL MEAN NAME DISTANCE AND DIRECTION	MEAN (F) [b] RANGE [b]	CONTROL LOCATIONS MEAN (F) [b] RANGE [b]	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
GAMMA (GELI) 2e						
K-40	NOT ESTAB	21.78(1/ 13)	BFN WELL #6	21.78(1/ 13)	15.98(2/ 13)	
		21.78- 21.78	0.02 MILES W	21.78- 21.78	12.05- 19.91	
BI-214	NOT ESTAB	7.23(11/ 13)	BFN WELL #6	7.23(11/ 13)	187.44(13/ 13)	
		0.12- 14.30	0.02 MILES W	0.12- 14.30	14.57- 344.52	
PB-214	NOT ESTAB	7.50(7/ 13)	BFN WELL #6	7.50(7/ 13)	186.72(13/ 13)	
		2.74- 13.26	0.02 MILES W	2.74- 13.26	28.92- 367.80	
PB-212	NOT ESTAB	1.07(3/ 13)	BFN WELL #6	1.07(3/ 13)	3.89(3/ 13)	
		0.07- 2.32	0.02 MILES W	0.07- 2.32	3.10- 5.41	
TL-208	NOT ESTAB	1.03(2/ 13)	BFN WELL #6	1.03(2/ 13)	0.64(3/ 13)	
		0.39- 1.68	0.02 MILES W	0.39- 1.68	0.01- 0.96	
AC-228	NOT ESTAB	13 VALUES <LLD			4.39(2/ 13)	
					2.47- 6.30	
TRITIUM	330.000	4 VALUES <LLD			4 VALUES <LLD	
8		ANALYSIS PERFORMED				

a. Nominal Lower Limit of Detection (LLD) as described in Table 3.

b. Mean and range based upon detectable measurements only. Fraction of detectable measurements at specified locations is indicated in parentheses (F).

TABLE 14

RADIOACTIVITY IN PUBLIC WATER SUPPLY

PCI/L - 0.037 BQ/L

NAME OF FACILITY BROWNS FERRY — DOCKET NO. 50-259,260,296

LOCATION OF FACILITY LIMESTONE, ALABAMA — REPORTING PERIOD 1984

TYPE AND TOTAL NUMBER OF ANALYSIS PERFORMED	LOWER LIMIT OF DETECTION [a] (LLD)	ALL INDICATOR LOCATIONS MEAN (F) [b] RANGE [b]	LOCATION WITH HIGHEST ANNUAL MEAN NAME DISTANCE AND DIRECTION	MEAN (F) [b] RANGE [b]	CONTROL LOCATIONS MEAN (F) [b] RANGE [b]	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
GROSS BETA	2.400	3.00(46/ 77)	CHAMPION PAPER	3.62(40/ 52)	3.06(5/ 13)	
90		2.41- 5.10	TRM 282.6	2.46- 5.10	2.55- 3.51	
GAMMA (GELI)						
91						
K-40	NOT ESTAB	17.88(6/ 78)	CHAMPION PAPER	18.62(5/ 52)	28.73(1/ 13)	
		9.70- 33.96	TRM 282.6	9.70- 33.96	28.73- 28.73	
BI-214	NOT ESTAB	5.64(46/ 78)	WHEELER DAM, AL	6.86(9/ 13)	6.23(9/ 13)	
		0.14- 24.79	TRM 274.9	2.85- 12.98	3.69- 8.77	
PB-214	NOT ESTAB	4.28(26/ 78)	CHAMPION PAPER	5.17(14/ 52)	5.50(6/ 13)	
		0.35- 19.47	TRM 282.6	0.41- 19.47	1.84- 11.36	
PB-212	NOT ESTAB	1.59(23/ 78)	SHEFFIELD, AL ROB	2.38(4/ 13)	1.95(6/ 13)	
		0.15- 4.50	TRM 254.5	0.58- 4.50	0.37- 4.44	
TL-208	NOT ESTAB	1.18(11/ 78)	WHEELER DAM, AL	1.37(2/ 13)	1.65(5/ 13)	
		0.28- 3.28	TRM 274.9	1.22- 1.52	0.23- 2.82	
AC-228	NOT ESTAB	6.19(7/ 78)	CHAMPION PAPER	7.73(4/ 52)	0.96(1/ 13)	
		1.08- 17.19	TRM 282.6	1.08- 17.19	0.96- 0.96	
SR 89	10.000	12 VALUES <LLD			4 VALUES <LLD	
16		ANALYSIS PERFORMED				
SR 90	2.000	12 VALUES <LLD			4 VALUES <LLD	
16		ANALYSIS PERFORMED				
TRITIUM	330.000	12 VALUES <LLD			4 VALUES <LLD	
16		ANALYSIS PERFORMED				

a. Nominal Lower Limit of Detection (LLD) as described in Table 3.
b. Mean and range based upon detectable measurements only. Fraction of detectable measurements at specified locations is indicated in parentheses (F).

Table 15

ENVIRONMENTAL GAMMA RADIATION LEVELS

Average External Gamma Radiation Levels at Various Distances from Browns Ferry Nuclear Plant for Each Quarter - 1984
mR/Quarter[a]

Distance Miles	Average External Gamma Radiation Levels[b]			
	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
0-1	19.4±1.7	19.9±1.4	21.9±3.0	20.5±1.5
1-2	18.5±2.0	17.5±1.7	19.2±3.7	19.4±2.2
2-4	17.5±1.5	17.8±1.9	17.7±3.5	17.8±2.1
4-6	16.9±1.3	17.5±1.7	17.2±2.7	17.9±1.4
>6	16.7±1.3	16.4±1.1	15.9±2.6	17.1±1.5
Average, 0-2 miles (Onsite)	19.5±1.8	19.3±1.7	21.2±3.2	20.2±1.7
Average, >2 miles (Offsite)	16.9±1.3	17.2±1.6	16.9±2.8	17.6±1.6

[a]Date normalized to one quarter (2190 hours)

[b]All averages reported ±1σ (68% confidence level)

TABLE 16

RADIOACTIVITY IN CABBAGE

PCI/KG - 0.037 BQ/KG (WET WEIGHT)

NAME OF FACILITY BROWNS FERRY DOCKET NO. 50-259,260,296
LOCATION OF FACILITY LIMESTONE ALABAMA REPORTING PERICD 1984

TYPE AND TOTAL NUMBER OF ANALYSIS PERFORMED	LOWER LIMIT OF DETECTION [a] (LLD)	ALL INDICATOR LOCATIONS MEAN (F) [b] RANGE [b]	LOCATION WITH HIGHEST ANNUAL MEAN NAME DISTANCE AND DIRECTION	MEAN (F) [b] RANGE [b]	CONTROL LOCATIONS MEAN (F) [b] RANGE [b]	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
GROSS BETA	25.000	3903.25(1/ 1)	7 MILES NNW	3903.25(1/ 1)	3687.18(1/ 1)	
2		3903.25- 3903.25		3903.25- 3903.25	3687.18- 3687.18	
GAMMA (GELI)						
2						
K-40	NOT ESTAB	1557.05(1/ 1)	7 MILES NNW	1557.05(1/ 1)	2257.49(1/ 1)	
		1557.05- 1557.05		1557.05- 1557.05	2257.49- 2257.49	
BI-214	NOT ESTAB	1 VALUES <LLD			4.96(1/ 1)	
					4.96- 4.96	
PB-214	NOT ESTAB	1 VALUES <LLD			5.13(1/ 1)	
					5.13- 5.13	
PB-212	NOT ESTAB	2.24(1/ 1)	7 MILES NNW	2.24(1/ 1)	0.91(1/ 1)	
		2.24- 2.24		2.24- 2.24	0.91- 0.91	

a. Nominal Lower Limit of Detection (LLD) as described in Table 3.
b. Mean and range based upon detectable measurements only. Fraction of detectable measurements at specified locations is indicated in parentheses (F).

TABLE 17

RADIOACTIVITY IN CORN

PCI/KG - 0.037 BQ/KG (WET WEIGHT)

NAME OF FACILITY BROWNS FERRY — DOCKET NO. 50-259,260,296
LOCATION OF FACILITY LIMESTONE ALABAMA — REPORTING PERIOD 1984

TYPE AND TOTAL NUMBER OF ANALYSIS PERFORMED	LOWER LIMIT OF DETECTION[a] (LLD)	ALL INDICATOR LOCATIONS MEAN (F)[b] RANGE[b]	LOCATION WITH HIGHEST ANNUAL MEAN NAME DISTANCE AND DIRECTION	MEAN (F)[b] RANGE[b]	CONTROL LOCATIONS MEAN (F)[b] RANGE[b]	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
GROSS BETA	25.000	3551.07(1/ 1)	7 MILES NNW	3551.07(1/ 1)	2172.74(1/ 1)	
2		3551.07- 3551.07		3551.07- 3551.07	2172.74- 2172.74	
GAMMA (GELI)						
2						
K-40	NOT ESTAB	2254.39(1/ 1)	7 MILES NNW	2254.39(1/ 1)	2094.54(1/ 1)	
		2254.39- 2254.39		2254.39- 2254.39	2094.54- 2094.54	
BI-214	NOT ESTAB	1 VALUES <LLD			3.86(1/ 1)	
					3.86- 3.86	
PB-214	NOT ESTAB	1 VALUES <LLD			0.48(1/ 1)	
					0.48- 0.48	
PB-212	NOT ESTAB	1.44(1/ 1)	7 MILES NNW	1.44(1/ 1)	1 VALUES <LLD	
		1.44- 1.44		1.44- 1.44		

a. Nominal Lower Limit of Detection (LLD) as described in Table 3.
b. Mean and range based upon detectable measurements only. Fraction of detectable measurements at specified locations is indicated in parentheses (F).

33

TABLE 18

RADIOACTIVITY IN PEACHES

PCI/KG - 0.037 BQ/KG (WET WEIGHT)

NAME OF FACILITY BROWNS FERRY — DOCKET NO. 50-259,260,296
LOCATION OF FACILITY LIMESTONE ALABAMA — REPORTING PERIOD 1984

TYPE AND TOTAL NUMBER OF ANALYSIS PERFORMED	LOWER LIMIT OF DETECTION [a] (LLD)	ALL INDICATOR LOCATIONS MEAN (F) [b] RANGE [b]	LOCATION WITH HIGHEST ANNUAL MEAN NAME DISTANCE AND DIRECTION	MEAN (F) [b] RANGE [b]	CONTROL LOCATIONS MEAN (F) [b] RANGE [b]	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
GROSS BETA	25.000	2273.65(1/ 1)	4 MILES N	2273.65(1/ 1)	2772.95(1/ 1)	
2		2273.65- 2273.65		2273.65- 2273.65	2772.95- 2772.95	
GAMMA (GELI)						
2						
K-40	NOT ESTAB	1955.30(1/ 1)	4 MILES N	1955.30(1/ 1)	1595.08(1/ 1)	
		1955.30- 1955.30		1955.30- 1955.30	1595.08- 1595.08	
BI-214	NOT ESTAB	0.79(1/ 1)	4 MILES N	0.79(1/ 1)	5.79(1/ 1)	
		0.79- 0.79		0.79- 0.79	5.79- 5.79	
PB-214	NOT ESTAB	9.47(1/ 1)	4 MILES N	9.47(1/ 1)	2.46(1/ 1)	
		9.47- 9.47		9.47- 9.47	2.46- 2.46	
PB-212	NOT ESTAB	0.98(1/ 1)	4 MILES N	0.98(1/ 1)	1.68(1/ 1)	
		0.98- 0.98		0.98- 0.98	1.68- 1.68	

a. Nominal Lower Limit of Detection (LLD) as described in Table 3.
b. Mean and range based upon detectable measurements only. Fraction of detectable measurements at specified locations is indicated in parentheses (F).

TABLE 19

RADIOACTIVITY IN PEAS

PCI/KG - C.037 BQ/KG (WET WEIGHT)

NAME OF FACILITY BROWNS FERRY — DOCKET NO. 50-259,260,296
LOCATION OF FACILITY LIMESTONE ALABAMA — REPORTING PERIOD 1994

TYPE AND TOTAL NUMBER OF ANALYSIS PERFORMED	LOWER LIMIT OF DETECTION[a] (LLD)	ALL INDICATOR LOCATIONS MEAN (F)[b] RANGE[b]	LOCATION WITH HIGHEST ANNUAL MEAN NAME DISTANCE AND DIRECTION	MEAN (F)[b] RANGE[b]	CONTROL LOCATIONS MEAN (F)[b] RANGE[b]	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
GROSS BETA	25.000	6965.66(1/ 1)	4 MILES N	6965.66(1/ 1)	5614.87(1/ 1)	
2		6965.66- 6965.66		6965.66- 6965.66	5614.87- 5614.87	
GAMMA (GELI)						
2						
K-40	NOT ESTAB	3461.39(1/ 1)	4 MILES N	3461.39(1/ 1)	3651.65(1/ 1)	
		3461.39- 3461.39		3461.39- 3461.39	3651.65- 3651.65	
BI-214	NOT ESTAB	6.03(1/ 1)	4 MILES N	6.03(1/ 1)	1 VALUES <LLD	
		6.03- 6.03		6.03- 6.03		
PB-214	NOT ESTAB	5.03(1/ 1)	4 MILES N	5.03(1/ 1)	1 VALUES <LLD	
		5.03- 5.03		5.03- 5.03		
		5.03- 5.03		5.03- 5.03		

a. Nominal Lower Limit of Detection (LLD) as described in Table 3.
b. Mean and range based upon detectable measurements only. Fraction of detectable measurements at specified locations is indicated in parentheses (F).

35

TABLE 20

RADIOACTIVITY IN POTATOES

PCI/KG - 0.037 BQ/KG (WET WEIGHT)

NAME OF FACILITY BROWNS FERRY — DOCKET NO. 50-259,260,296

LOCATION OF FACILITY LIMESTONE ALABAMA — REPORTING PERIOD 1994

TYPE AND TOTAL NUMBER OF ANALYSIS PERFORMED	LOWER LIMIT OF DETECTION[a] (LLD)	ALL INDICATOR LOCATIONS MEAN (F)[b] RANGE	LOCATION WITH HIGHEST ANNUAL MEAN NAME DISTANCE AND DIRECTION	MEAN (F)[b] RANGE	CONTROL LOCATIONS MEAN (F)[b] RANGE	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
GROSS BETA	25.000	7312.07(1/ 1)	7 MILES NNW	7312.07(1/ 1)	6571.60(1/ 1)	
2		7312.07- 7312.07		7312.07- 7312.07	6571.60- 6571.60	
GAMMA (GELI)						
2						
K-40	NOT ESTAB	3287.97(1/ 1)	7 MILES NNW	3287.97(1/ 1)	3924.85(1/ 1)	
		3287.97- 3287.97		3287.97- 3287.97	3924.85- 3924.85	
BI-214	NOT ESTAB	2.73(1/ 1)	7 MILES NNW	2.73(1/ 1)	3.29(1/ 1)	
		2.73- 2.73		2.73- 2.73	3.29- 3.29	
PB-214	NOT ESTAB	0.78(1/ 1)	7 MILES NNW	0.78(1/ 1)	12.44(1/ 1)	
		0.78- 0.78		0.78- 0.78	12.44- 12.44	
PB-212	NOT ESTAB	0.83(1/ 1)	7 MILES NNW	0.83(1/ 1)	1 VALUES <LLD	
		0.83- 0.83		0.83- 0.83		

a. Nominal Lower Limit of Detection (LLD) as described in Table 3.
b. Mean and range based upon detectable measurements only. Fraction of detectable measurements at specified locations is indicated in parentheses (F).

36

TABLE 21

RADIOACTIVITY IN POULTRY

PCI/KG - 0.037 BQ/KG (WET WEIGHT)

NAME OF FACILITY BROWNS FERRY — DOCKET NO. 50-259,260,296
LOCATION OF FACILITY LIMESTONE ALABAMA — REPORTING PERIOD 1984

TYPE AND TOTAL NUMBER OF ANALYSIS PERFORMED	LOWER LIMIT OF DETECTION[a] (LLD)	ALL INDICATOR LOCATIONS MEAN (F)[b] RANGE[b]	LOCATION WITH HIGHEST ANNUAL MEAN NAME DISTANCE AND DIRECTION	MEAN (F)[b] RANGE[b]	CONTROL LOCATIONS MEAN (F)[b] RANGE[b]	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
GROSS BETA	25.000	5016.47(1/ 1)	PAGE FARM	5016.47(1/ 1)	4902.94(1/ 1)	
[2]		5016.47- 5016.47	8.75 MILES E	5016.47- 5016.47	4902.94- 4902.94	
GAMMA (GELI)						
[2]						
K-40	NOT ESTAB	2511.67(1/ 1)	PAGE FARM	2511.67(1/ 1)	2317.20(1/ 1)	
		2511.67- 2511.67	8.75 MILES E	2511.67- 2511.67	2317.20- 2317.20	
BI-214	NOT ESTAB	12.62(1/ 1)	PAGE FARM	12.62(1/ 1)	8.41(1/ 1)	
		12.62- 12.62	8.75 MILES E	12.62- 12.62	8.41- 8.41	
PB-214	NOT ESTAB	8.61(1/ 1)	PAGE FARM	8.61(1/ 1)	8.90(1/ 1)	
		8.61- 8.61	8.75 MILES E	8.61- 8.61	8.90- 8.90	

a. Nominal Lower Limit of Detection (LLD) as described in Table 3.
b. Mean and range based upon detectable measurements only. Fraction of detectable measurements at specified locations is indicated in parentheses (F).

37

TABLE 22

RADIOACTIVITY IN TOMATOES

PCI/KG - 0.037 BQ/KG (WET WEIGHT)

NAME OF FACILITY BROWNS FERRY — DOCKET NO. 50-259,260,296

LOCATION OF FACILITY LIMESTONE ALABAMA — REPORTING PERIOD 1986

TYPE AND TOTAL NUMBER OF ANALYSIS PERFORMED	LOWER LIMIT OF DETECTION[a] (LLD)	ALL INDICATOR LOCATIONS MEAN (F)[b] RANGE[b]	LOCATION WITH HIGHEST ANNUAL MEAN NAME DISTANCE AND DIRECTION	MEAN (F)[b] RANGE[b]	CONTROL LOCATIONS MEAN (F)[b] RANGE[b]	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
GROSS BETA 2	25.000	1617.91(1/ 1) 1617.91- 1617.91	7 MILES NNW	1617.91(1/ 1) 1617.91- 1617.91	3007.66(1/ 1) 3007.66- 3007.66	
GAMMA (GELI) 2						
K-40	NOT ESTAB	2161.25(1/ 1) 2161.25- 2161.25	7 MILES NNW	2161.25(1/ 1) 2161.25- 2161.25	2652.92(1/ 1) 2652.92- 2652.92	

a. Nominal Lower Limit of Detection (LLD) as described in Table 3.
b. Mean and range based upon detectable measurements only. Fraction of detectable measurements at specified locations is indicated in parentheses (F).

Figure 6

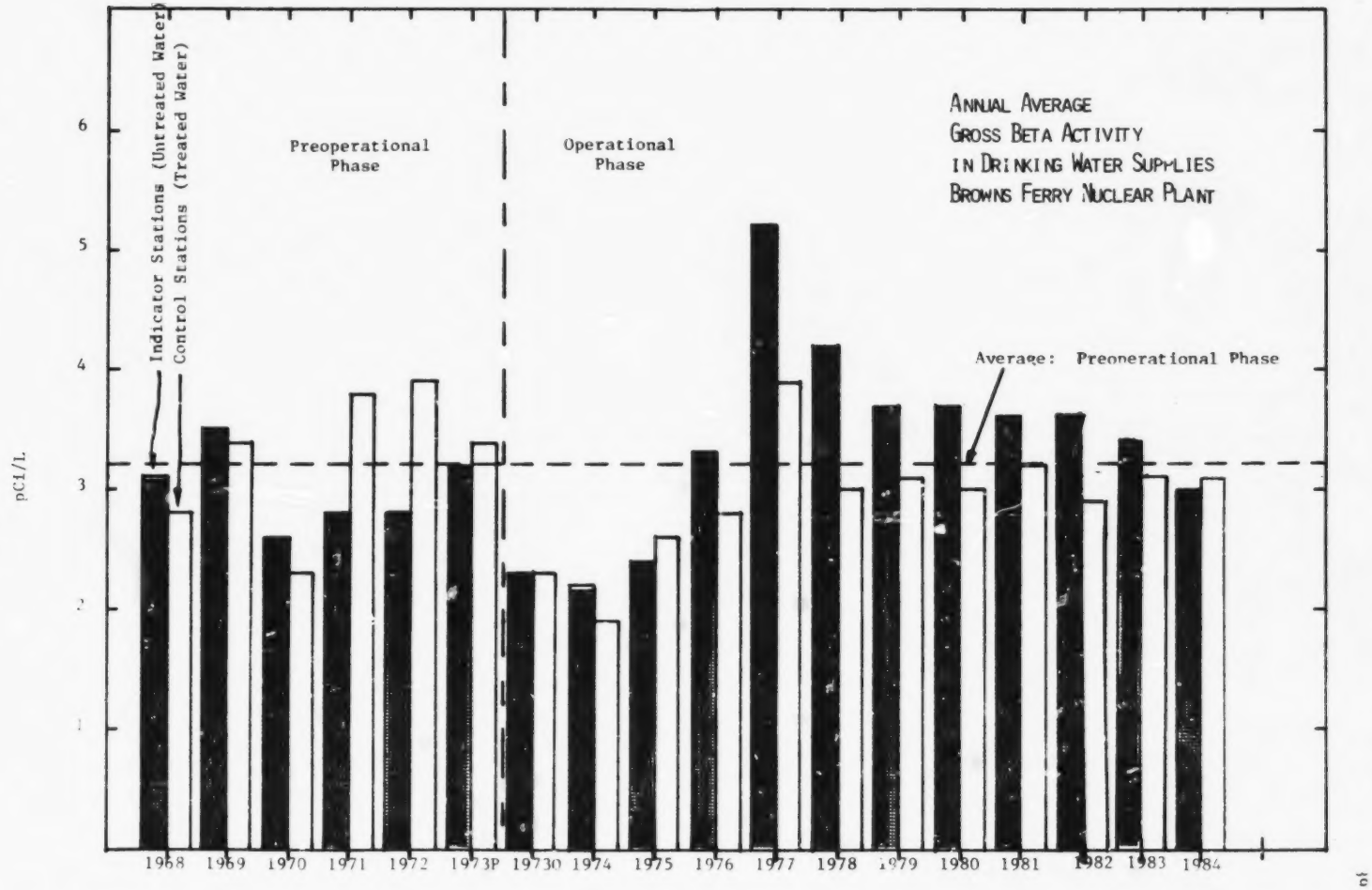

Indicator Stations (Untreated Water)
Control Stations (Treated Water)
Preoperational Phase
Operational Phase
Annual Average
Gross Beta Activity
In Drinking Water Supplies
Browns Ferry Nuclear Plant
Average: Preoperational Phase
pCi/L
6
5
4
3
1968 1969 1970 1971 1972 1973P 1973O 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984

Figure 7

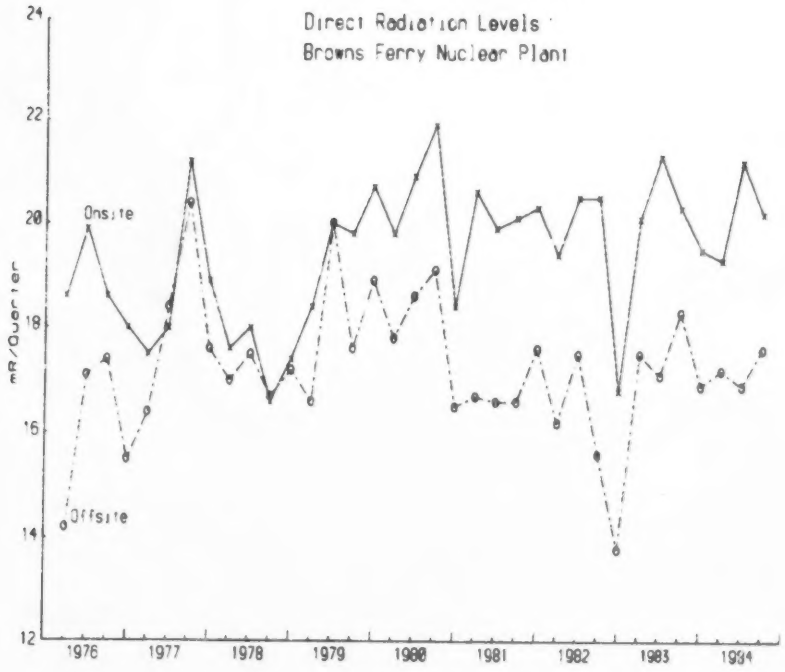


Figure 8

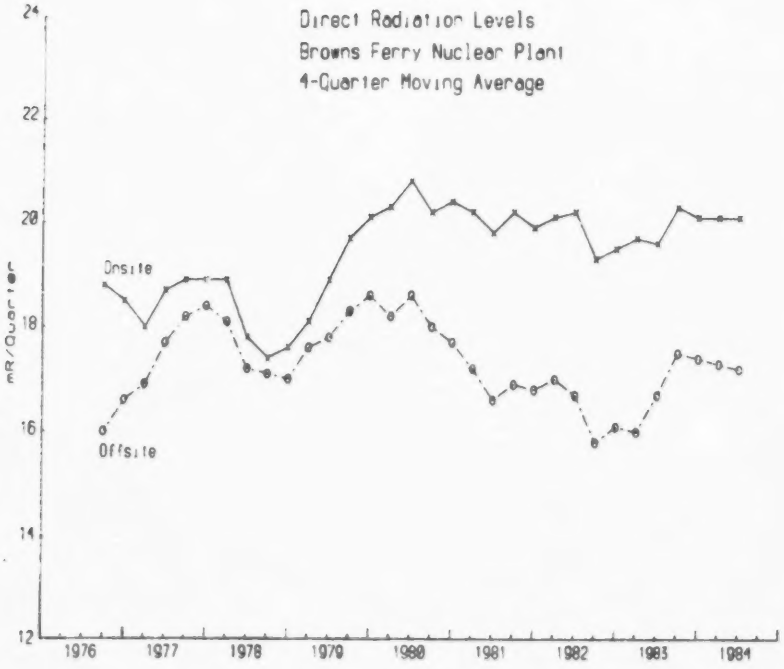


Figure 9

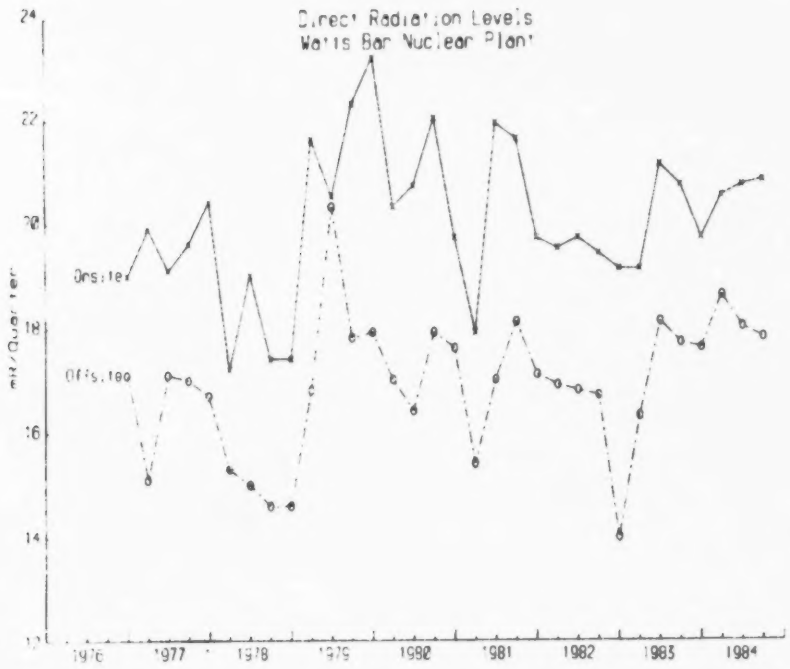


Figure 10

BLANK PAGE

Reservoir Monitoring

Samples are collected from various Tennessee River cross sections as detailed in table 23. Samples collected for radiological analysis include plankton from three of these cross sections and bottom fauna and sediment from four cross sections. The locations of these cross sections are shown on the accompanying map (figure 11) and conform to sediment ranges established and surveyed by TVA.

Water

Water samples are collected automatically by sequential type sampling devices at three cross sections and composite samples analyzed monthly for gross beta and gamma-emitting radionuclides. Further composites are made quarterly for strontium and tritium analyses. In addition to these required samples, grab samples were also collected monthly from the vicinity of the plant discharge to the Tennessee River, and at a point on the Elk River, and analyzed for gross beta, gamma-emitting radionuclides, and strontium. Results are displayed in table 24. Figure 12 presents a plot of the gross beta activity in surface water from 1968 through 1984. No gross beta measurements were made in surface water samples in 1978. The levels reported are consistent with gross beta levels measured in surface water samples taken from the Tennessee River in preoperational monitoring programs conducted by TVA at other sites.

Fish

Radiological monitoring for fish is accomplished by analysis of composite samples of adult fish taken from each of three contiguous reservoirs--Wilson, Wheeler, and Guntersville. No permanent sampling stations have been established within each reservoir; this reflects the movement of fish species within reservoirs as determined by TVA data from the BFN preoperational monitoring program. Two species, white crappie and smallmouth buffalo, are collected representing both commercial and game species. Sufficient fish are collected in each reservoir to yield 250 to 300 grams oven-dry weight for analytical purposes. All samples are collected semiannually and analyzed for gamma-emitting radionuclides. The composite samples contain approximately the same quantity of flesh from each fish. For each composite a subsample of material is drawn for counting. Results are given in tables 25, 26, and 27.

Plankton

Net plankton (all phytoplankton and zooplankton caught with a 100 μ mesh net) is collected for radiological analyses at each of three stations by vertical tows with a 1/2-meter net. At least 50 grams (wet weight) of material is necessary for analytical accuracy. Samples are collected semiannually and submitted for gross beta analysis, and when quantities are sufficient, for gamma activity and ^{89}Sr and ^{90}Sr content. During this reporting period, samples collected during the first half of the year contained insufficient volume for any analysis. During the second half of the year, plankton could not be located in sufficient quantities to be collected.

Sediment

Sediment samples are collected semiannually from Ponar dredge hauls made for bottom fauna. Gamma radioactivity and ^{89}Sr and ^{90}Sr content are determined in composite samples collected from each of four stations. Locations of these stations are shown in table 23. Results are shown in table 28.

Bottom Fauna

The flesh and shells of Asiatic clams collected semiannually from the cross sections at four stations (table 23) are analyzed for gamma-emitting radionuclides. Levels of ^{89}Sr and ^{90}Sr are determined on the shells, and on the flesh when sufficient amounts were available. A 50-gram (wet weight) sample provides sufficient activity for counting. Results are given in tables 29 and 30. Clams from one location were not available; and from two locations, insufficient quantities were collected to permit analysis of clam flesh.

Table 23

SAMPLING SCHEDULE - RESERVOIR MONITORING

River/river mile	Biological samples (collected semiannually)				Water Samples (collected monthly)
	Zooplankton, chlorophyll, phytoplankton	Benthic fauna	Sediment	Fish[a]	
Tennessee 277.9	X	X	X		
Tennessee 285.2					b
Tennessee 288.7		X	X		
Tennessee 291.7	X				
Tennessee 293.5					b
Tennessee 293.7 (discharge area)		X	X		c
Tennessee 305.0 (Control)					b
Tennessee 307.5 (Control)	X	X	X		
Elk 20.5 (Control)					c

a. Gill net and/or electroshocker will be used for collection. Samples of fish are collected from Guntersville, Wheeler, and Wilson Reservoirs.
b. Automatic sampler.
c. Grab sample.

45

TABLE 24

RADIOACTIVITY IN SURFACE WATER TOTAL

PCI/L - 0.037 BQ/L

NAME OF FACILITY [illegible] DOCKET NO. [illegible]

LOCATION OF FACILITY [illegible] REPORTING PERIOD 1984

TYPE AND TOTAL NUMBER OF ANALYSIS PERFORMED	LOWER LIMIT OF DETECTION [a]	ALL INDICATOR LOCATIONS MEAN (F) [b] RANGE [b]	LOCATION WITH HIGHEST ANNUAL MEAN NAME DISTANCE AND DIRECTION	MEAN (F) [b] RANGE [b]	CONTROL LOCATIONS MEAN (F) [b] RANGE [b]	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
GROSS ALPHA	2.000	0 VALUES <LLD			1 VALUES <LLD	
1		ANALYSIS PERFORMED				
GROSS BETA	2.000	3.22(27/ 39)	TRM 293.5	3.31(8/ 13)	3.62(20/ 26)	
05		2.54- 5.18		2.54- 4.25	2.43- 12.00	
GAMMA (GELI)						
05						
K-40	NOT ESTAB	21.09(5/ 39)	TRM 285.2	23.05(1/ 13)	23.45(2/ 26)	
		0.59- 39.69		23.05- 23.05	19.74- 27.12	
BI-214	NOT ESTAB	5.56(14/ 39)	TRM 293.7	8.39(5/ 13)	8.57(15/ 26)	
		0.01- 19.71	BFA DISCHARGE	2.18- 18.71	0.72- 26.47	
PB-214	NOT ESTAB	3.06(7/ 39)	TRM 293.7	3.55(4/ 13)	6.71(14/ 26)	
		0.01- 7.14	BFA DISCHARGE	0.72- 7.14	0.59- 18.10	
PB-212	NOT ESTAB	1.81(20/ 39)	TRM 285.2	2.64(5/ 13)	2.64(7/ 26)	
		0.10- 4.52		0.99- 4.52	0.26- 5.65	
SR 89	10.000	12 VALUES <LLD			8 VALUES <LLD	
20		ANALYSIS PERFORMED				
SR 90	2.000	12 VALUES <LLD			8 VALUES <LLD	
20		ANALYSIS PERFORMED				
TRITIUM	330.000	367.92(2/ 12)	TRM 293.5	416.31(1/ 4)	8 VALUES <LLD	
20		359.53- 416.31		416.31- 416.31		

a. Nominal Lower Limit of Detection (LLD) as described in Table 3.
b. Mean and range based upon detectable measurements only. Fraction of detectable measurements at specified locations is indicated in parentheses (F).

TABLE 25

RADIOACTIVITY IN WHITE CRAPPIE (FLESH)

PCI/G - 0.037 BQ/G (DRY WEIGHT)

NAME OF FACILITY BROWNS FERRY — DOCKET NO. 50-259/260/296
LOCATION OF FACILITY LIMESTONE ALABAMA — REPORTING PERIOD 1976

TYPE AND TOTAL NUMBER OF ANALYSIS PERFORMED	LOWER LIMIT OF DETECTION[a] (LLD)	ALL INDICATOR LOCATIONS MEAN (F)[b] RANGE[b]	LOCATION WITH HIGHEST ANNUAL MEAN NAME DISTANCE AND DIRECTION	MEAN (F)[b] RANGE[b]	CONTROL LOCATIONS MEAN (F)[b] RANGE[b]	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
GROSS BETA	0.100	28.19(4/ 4)	WHEELER RES	29.09(2/ 2)	26.99(2/ 2)	
[c]		21.10- 35.50	TRM 275-349	25.19- 32.98	20.46- 37.53	
GAMMA (GELI)	[c]					
CS-137	0.020	0.09(3/ 4)	WILSON RESERVOIR	0.11(1/ 2)	0.09(2/ 2)	
		0.02- 0.11	TRM 259-275	0.11- 0.11	0.07- 0.11	
K-40	NOT ESTAB	15.30(4/ 4)	WHEELER RES	16.14(2/ 2)	14.29(2/ 2)	
		12.80- 17.51	TRM 275-349	14.77- 17.51	11.72- 16.85	
BI-214	0.020	0.04(1/ 4)	WHEELER RES	0.04(1/ 2)	0.02(1/ 2)	
		0.04- 0.04	TRM 275-349	0.04- 0.04	0.02- 0.02	
PB-214	NOT ESTAB	0.17(2/ 4)	WILSON RESERVOIR	0.26(1/ 2)	0.03(1/ 2)	
		0.05- 0.28	TRM 259-275	0.22- 0.28	0.03- 0.03	
PB-212	NOT ESTAB	0.01(1/ 4)	WHEELER RES	0.01(1/ 2)	0.00(1/ 2)	
		0.01- 0.01	TRM 275-349	0.01- 0.01	0.00- 0.00	
SR 89	0.500	2 VALUES <LLD			1 VALUES <LLD	
[3]		ANALYSIS PERFORMED				
SR 90	0.100	2 VALUES <LLD			1 VALUES <LLD	
[3]		ANALYSIS PERFORMED				

a. Nominal Lower Limit of Detection (LLD) as described in Table 3.
b. Mean and range based upon detectable measurements only. Fraction of detectable measurements at specified locations is indicated in parentheses (F).

TABLE 26

RADIOACTIVITY IN SMALLMOUTH BUFFALO (FLESH)

PCI/G - 0.037 BQ/G (DRY WEIGHT)

NAME OF FACILITY [illegible] DOCKET NO. [illegible]

LOCATION OF FACILITY [illegible] REPORTING PERIOD [illegible]

TYPE AND TOTAL NUMBER OF ANALYSIS PERFORMED	LOWER LIMIT OF DETECTION[a]	ALL INDICATOR LOCATIONS MEAN (F)[b] RANGE[b]	LOCATION WITH HIGHEST ANNUAL MEAN NAME	MEAN (F)[b]	RANGE[b]	CONTROL LOCATIONS MEAN (F)[b]	RANGE[b]	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
GROSS BETA	0.100	25.56(4/ 4)	WHEELER RES	32.28(	2/ 2)	20.42(	2/ 2)	
		12.72- 39.1e	TRM 275-349	25.39-	39.1e	19.8e-	20.9e	
e								
GAMMA (GELI)								
e								
CS-137	0.020	0.05(3/ 4)	WHEELER RES	0.06(	2/ 2)	0.0e(	1/ 2)	
		0.04- 0.07	TRM 275-349	0.04-	0.07	0.0e-	0.0e	
K-40	NOT ESTAB	12.96(4/ 4)	WHEELER RES	15.44(	2/ 2)	12.11(	2/ 2)	
		6.89- 18.33	TRM 275-349	12.55-	18.33	9.34-	14.88	
BI-214	0.030	0.04(2/ 4)	WILSON RESERVOIR	0.05(	1/ 2)	2 VALUES <LLD		
		0.04- 0.05	TRM 259-275	0.05-	0.05			
PB-214	NOT ESTAB	0.04(3/ 4)	WILSON RESERVOIR	0.06(	1/ 2)	0.02(	2/ 2)	
		0.02- 0.06	TRM 259-275	0.06-	0.06	0.01-	0.03	
PB-212	NOT ESTAB	0.01(1/ 4)	WHEELER RES	0.01(	1/ 2)	0.01(	2/ 2)	
		0.01- 0.01	TRM 275-349	0.01-	0.01	0.00-	0.01	
SR 89	0.500	3 VALUES <LLD				1 VALUES <LLD		
4		ANALYSIS PERFORMED						
SR 90	0.100	3 VALUES <LLD				1 VALUES <LLD		
4		ANALYSIS PERFORMED						

a. Nominal Lower Limit of Detection (LLD) as described in Table 3.
b. Mean and range based upon detectable measurements only. Fraction of detectable measurements at specified locations is indicated in parentheses (F).

BLANK PAGE

BLANK PAGE

BLANK PAGE

TABLE 27

RADIOACTIVITY IN SMALLMOUTH BUFFALO (WHOLE)

PCI/G - 0.037 BQ/G (DRY WEIGHT)

NAME OF FACILITY: BROWNS FERRY — DOCKET NO.: 50-259/260/296
LOCATION OF FACILITY: LIMESTONE ALABAMA — REPORTING PERIOD: 1978

TYPE AND TOTAL NUMBER OF ANALYSIS PERFORMED	LOWER LIMIT OF DETECTION[a] (LLD)	ALL INDICATOR LOCATIONS MEAN (F)[b] RANGE[b]	INDICATOR LOCATIONS NAME	INDICATOR LOCATIONS MEAN (F)[b]	CONTROL LOCATIONS MEAN (F)[b] RANGE[b]	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
GROSS BETA	0.100	20.52(4/ 4)	WILSON RESERVOIR	23.60(2/ 2)	18.96(2/ 2)	
		13.60- 33.71	TRM 259-275	13.60- 33.71	15.69- 18.25	
GAMMA (GELI)[c]						
CS-137	0.020	0.04(2/ 4)	WILSON RESERVOIR	0.04(2/ 2)	0.02(1/ 2)	
		0.03- 0.04	TRM 259-275	0.03- 0.04	0.02- 0.02	
K-40	NOT ESTAB	8.56(4/ 4)	WILSON RESERVOIR	9.65(2/ 2)	7.61(2/ 2)	
		7.27- 10.79	TRM 259-275	8.51- 10.79	7.61- 7.62	
BI-214	0.020	0.03(2/ 4)	WILSON RESERVOIR	0.04(1/ 2)	0.05(1/ 2)	
		0.02- 0.04	TRM 259-275	0.04- 0.04	0.05- 0.05	
PB-214	NOT ESTAB	0.04(2/ 4)	WHEELER RES	0.05(1/ 2)	0.04(1/ 2)	
		0.03- 0.05	TRM 275-349	0.05- 0.05	0.04- 0.04	
PB-212	NOT ESTAB	0.01(1/ 4)	WHEELER RES	0.01(1/ 2)	0.01(1/ 2)	
		0.01- 0.01	TRM 275-349	0.01- 0.01	0.01- 0.01	
RA-226	NOT ESTAB	0.26(1/ 4)	WILSON RESERVOIR	0.26(1/ 2)	2 VALUES <LLD	
		0.26- 0.26	TRM 259-275	0.26- 0.26		
AC-228	0.050	0.06(1/ 4)	WILSON RESERVOIR	0.06(1/ 2)	2 VALUES <LLD	
		0.06- 0.06	TRM 259-275	0.06- 0.06		
SR-89	0.500	2 VALUES <LLD			1 VALUES <LLD	
SR-90[d]	0.100	ANALYSIS PERFORMED				
		2 VALUES <LLD			0.23(1/ 1)	
					0.23- 0.23	

a. Nominal Lower Limit of Detection (LLD) as described in Table 3.
b. Mean and range based upon detectable measurements only. Fraction of detectable measurements at specified locations is indicated in parentheses (F).

TABLE 28

RADIOACTIVITY IN SEDIMENT

PCI/G - 0.037 BQ/G (DRY WEIGHT)

NAME OF FACILITY [illegible] DOCKET NO. [illegible]

LOCATION OF FACILITY [illegible] REPORTING PERIOD 1984

TYPE AND TOTAL NUMBER OF ANALYSIS PERFORMED GAMMA (GELI)	LOWER LIMIT OF DETECTION[a]	ALL INDICATOR LOCATIONS MEAN (F)[b] RANGE[b]	INDICATOR LOCATION WITH HIGHEST ANNUAL MEAN NAME DISTANCE AND DIRECTION	MEAN (F)[b] RANGE[b]	CONTROL LOCATIONS MEAN (F)[b] RANGE[b]	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
CO-60[c]	0.010	0.31(4/ 5) 0.27- 0.36	TRM 277.9S	0.32(1/ 2) 0.32- 0.32	0.02(1/ 2) 0.02- 0.02	
CS-134[c]	0.020	0.14(2/ 6) 0.10- 0.17	TRM 293.7 BFN DISCHARGE	0.17(1/ 2) 0.17- 0.17	2 VALUES <LLD	
CS-137[c]	0.020	0.90(6/ 6) 0.78- 1.12	TRM 277.9S	0.95(2/ 2) 0.78- 1.12	0.48(2/ 2) 0.30- 0.65	
K-40	NOT ESTAB	14.02(6/ 6) 11.78- 16.62	TRM 277.9S	15.54(2/ 2) 14.20- 16.82	10.64(2/ 2) 7.91- 13.36	
BI-214	0.020	1.37(6/ 6) 0.94- 1.62	TRM 277.9S	1.49(2/ 2) 1.44- 1.54	1.11(2/ 2) 1.01- 1.21	
BI-212	0.100	2.01(4/ 6) 1.88- 2.08	TRM 277.9S	2.06(2/ 2) 2.06- 2.06	1.45(2/ 2) 1.38- 1.53	
PB-214	NOT ESTAB	1.55(6/ 6) 1.21- 1.68	TRM 282.7E	1.64(2/ 2) 1.61- 1.68	1.25(2/ 2) 1.16- 1.34	
PB-212	NOT ESTAB	1.44(6/ 6) 1.33- 1.61	TRM 277.9S	1.60(2/ 2) 1.38- 1.81	1.21(2/ 2) 1.18- 1.24	
RA-226	NOT ESTAB	1.52(2/ 6) 1.51- 1.54	TRM 277.9S	1.54(1/ 2) 1.54- 1.54	1.11(2/ 2) 1.01- 1.21	
RA-224	NOT ESTAB	1.69(1/ 6) 1.69- 1.69	TRM 293.7 BFN DISCHARGE	1.69(1/ 2) 1.69- 1.69	1.28(1/ 2) 1.28- 1.28	
TL-208	0.020	0.55(6/ 6) 0.33- 0.81	TRM 277.9S	0.56(2/ 2) 0.52- 0.61	0.41(2/ 2) 0.38- 0.44	
AC-228	0.060	1.50(6/ 6) 1.17- 1.94	TRM 277.9S	1.73(2/ 2) 1.52- 1.94	1.22(2/ 2) 1.18- 1.26	
PA-234M	NOT ESTAB	3.40(1/ 6) 3.40- 3.40	TRM 277.9S	3.40(1/ 2) 3.40- 3.40	2 VALUES <LLD	
SR-89	1.500	6 VALUES <LLD ANALYSIS PERFORMED			2 VALUES <LLD	
SR-90	0.300	6 VALUES <LLD ANALYSIS PERFORMED			2 VALUES <LLD	

a. Nominal Lower Limit of Detection (LLD) as described in Table 3.

b. Mean and range based upon detectable measurements only. Fraction of detectable measurements at specified locations is indicated in parentheses (F).

c. The distribution of ^{60}Co and ^{137}Cs between indicator and control locations reported herein is comparable to the distribution reported in the preoperational monitoring program from 1963 to mid-1973. The levels reported for the isotopes and for ^{137}Cs are also comparable with levels reported in samples from the Tennessee River in preoperational monitoring programs conducted by TVA at other sites.

TABLE 20

RADIOACTIVITY IN CLAM FLESH

FCI/G - 0.037 BQ/G (DRY WEIGHT)

NAME OF FACILITY [illegible] DOCKET NO. [illegible]
LOCATION OF FACILITY [illegible] REPORTING PERIOD 1984

TYPE AND TOTAL NUMBER OF ANALYSIS PERFORMED GAMMA (GELI) [5]	LOWER LIMIT OF DETECTION[a]	ALL INDICATOR LOCATIONS MEAN (F)[b] RANGE[b]	NAME	MEAN (F)[b]	CONTROL LOCATIONS MEAN (F)[b] RANGE[b]	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
K-40	NOT ESTAB	3 VALUES <LLD			2.06(2/ 2) 1.95- 2.17	
BI-214	NOT ESTAB	2.47(3/ 3) 1.46- 3.60	TRM 277.99	3.60(1/ 1) 3.60- 3.60	1.52(2/ 2) 0.41- 2.22	
PB-214	NOT ESTAB	2.33(3/ 3) 1.58- 2.75	TRM 277.98	2.75(1/ 1) 2.75- 2.75	0.83(2/ 2) 0.63- 1.07	
PB-212	NOT ESTAB	0.26(1/ 3) 0.25- 0.26	TRM 238.78	0.26(1/ 1) 0.26- 0.26	0.15(1/ 2) 0.15- 0.15	
TL-208	NOT ESTAB	3 VALUES <LLD			0.07(2/ 2) 0.03- 0.10	
AC-228	NOT ESTAB	3 VALUES <LLD			1.39(1/ 2) 1.39- 1.39	

a. Nominal Lower Limit of Detection (LLD) as described in Table 3.
b. Mean and range based upon detectable measurements only. Fraction of detectable measurements at specified locations is indicated in parentheses (F).

TABLE 30

RADIOACTIVITY IN CLAM SHELL

PCI/g - 1.037 BQ/G (DRY WEIGHT)

NAME OF FACILITY [illegible] DOCKET NO. [illegible]
LOCATION OF FACILITY [illegible] REPORTING PERIOD 1984

TYPE AND TOTAL NUMBER OF ANALYSIS PERFORMED GAMMA (GELI)	LOWER LIMIT OF DETECTION[a] (LLD)	ALL INDICATOR LOCATIONS MEAN (F)[b] RANGE[b]	LOCATION WITH HIGHEST ANNUAL MEAN NAME DISTANCE AND DIRECTION	MEAN (F)[b] RANGE[b]	CONTROL LOCATIONS MEAN (F)[b] RANGE[b]	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
K-40	NOT ESTAB	0.00(1/ 5) 0.00- 0.00	TRM 288.7E	0.00(1/ 2) 0.00- 0.00	0.13(1/ 2) 0.13- 0.13	
BI-214	0.030	0.22(3/ 5) 0.07- 0.42	TRM 293.7 8FA DISCHARGE	0.30(2/ 2) 0.17- 0.42	0.15(2/ 2) 0.06- 0.23	
PB-214	0.030	0.24(5/ 5) 0.09- 0.50	TRM 277.9E	0.50(1/ 1) 0.50- 0.50	0.14(2/ 2) 0.06- 0.29	
PB-212	NOT ESTAB	0.06(3/ 5) 0.04- 0.07	TRM 288.7E	0.06(2/ 2) 0.04- 0.07	0.02(1/ 2) 0.02- 0.02	
RA-226	0.060	0.07(1/ 5) 0.07- 0.07	TRM 288.7E	0.07(1/ 2) 0.07- 0.07	0.06(1/ 2) 0.06- 0.06	
AC-228	0.060	0.07(1/ 5) 0.07- 0.07	TRM 288.7E	0.07(1/ 2) 0.07- 0.07	0.07(1/ 2) 0.07- 0.07	
SR-89	5.000	6.24(1/ 5) 6.24- 6.24	TRM 293.7 8FA DISCHARGE	6.24(1/ 2) 6.24- 6.24	2 VALUES <LLD	
SR-90	1.000	1.14(4/ 5) 1.01- 1.24	TRM 288.7E	1.23(2/ 2) 1.21- 1.24	1.16(1/ 2) 1.16- 1.16	

a. Nominal Lower Limit of Detection (LLD) as described in Table 3.
b. Mean and range based upon detectable measurements only. Fraction of detectable measurements at specified locations is indicated in parentheses (F).

Figure 11

RESERVOIR MONITORING NETWORK

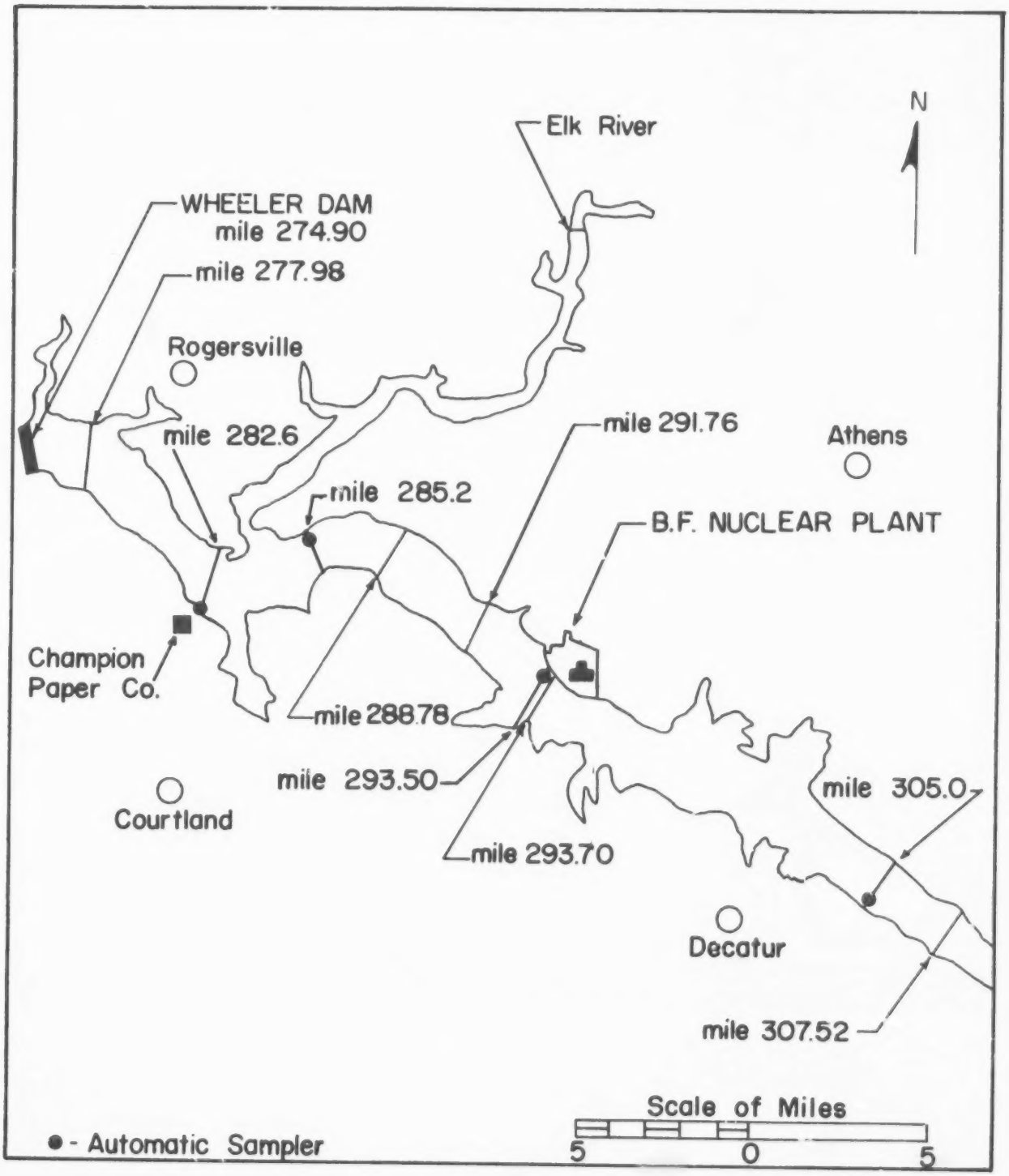
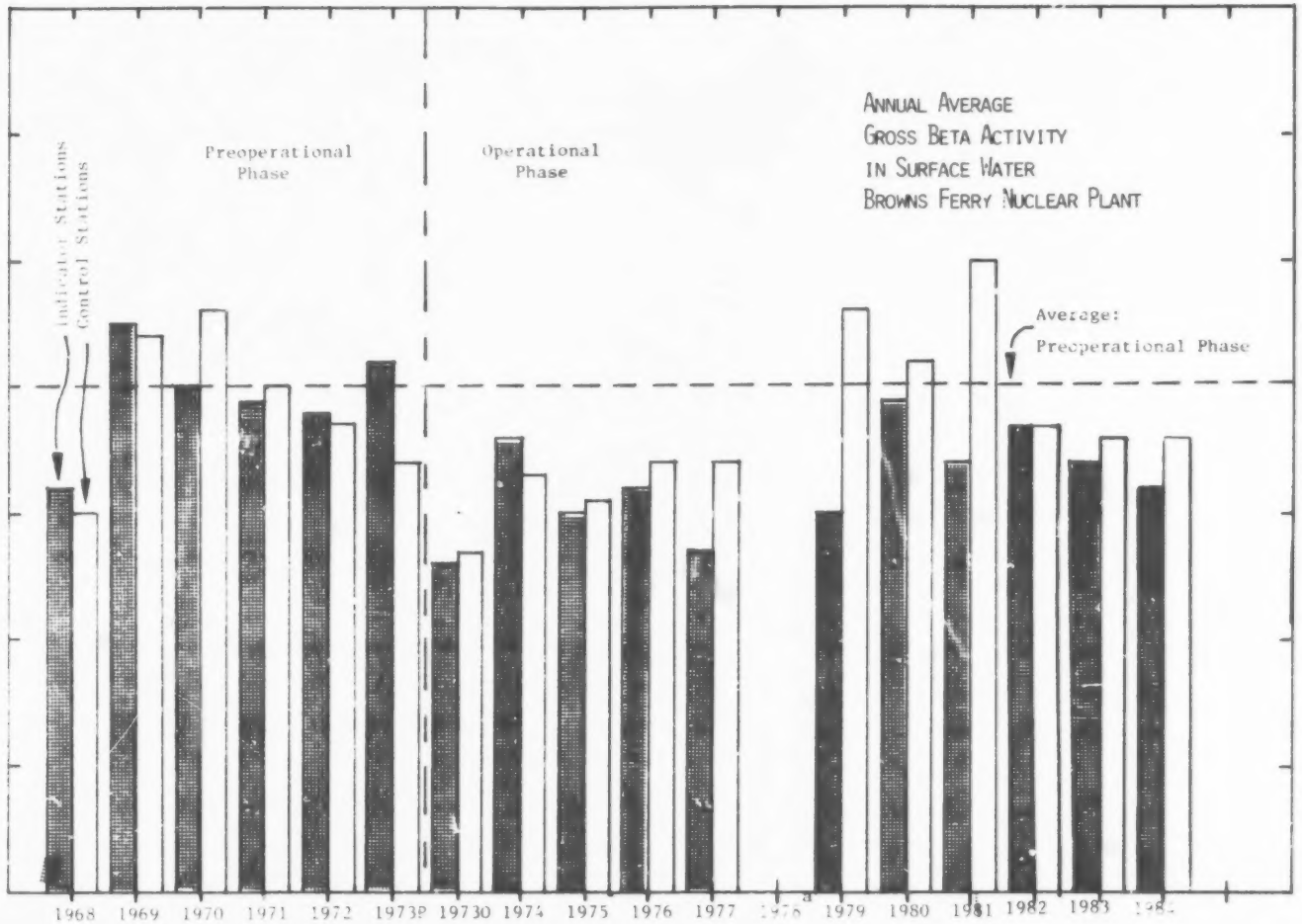


Figure 12



a. No gross beta measurements made in 1978.

Quality Control

A quality control program has been established with the Alabama Department of Public Health Environmental Health Administration Laboratory and the Eastern Environmental Radiation Facility, Environmental Protection Agency, Montgomery, Alabama. Samples of air, water, milk, and vegetation collected around BFN are forwarded to these laboratories for analysis, and results are exchanged for comparison.

Data Analysis

Data measured at the control stations for each medium were averaged for each sampling period. In order to describe the distribution of control station data, a mean, standard deviation, and 3-sigma limits were calculated. We can expect that background concentrations would be distributed within these limits. This provides us the basis for comparing control and indicator data. If the indicator data fall within the limits defined for control data, we conclude that the indicator data were not significantly affected by the nuclear plant. If the data do not fall within the limits, we will perform further analyses to determine if the difference is attributable to the nuclear plant.

Conclusions

A vast majority of the indicator station data was found to be within the distribution defined by the control station data. The data analysis software identified concentrations slightly exceeding the limits of the control station data for a small number of radionuclides in samples from indicator stations. Many of these values may be discounted because the error reported by the analysis program was greater than the calculated concentration. The remaining isolated elevated concentrations may be the result of fallout, fluctuations in the existing environment, computer program artifacts, or analytical errors. The same type of isolated high values occurred in the control station data and may be attributed to the same sources.

Dose estimates were made from concentrations of radioactivity found in samples of environmental media. Media sampled include, but are not limited to, air, milk, meat, vegetation, drinking water, and fish. Inhalation and ingestion doses estimated for persons at the indicator locations were essentially identical to those determined for persons at control locations. Greater than 99 percent of those doses were contributed by the naturally occurring radionuclide potassium-40, and by strontium-90 and cesium-137 which are long-lived radioisotopes found in fallout from nuclear weapons testing.

It is concluded from the above analysis of the data and from the trend plots presented earlier that there were no measurable increases in the exposure to members of the general public attributable to the operation of BFN. Indications of the presence of small quantities of fission products have been seen in aquatic media (for example, sediment). The levels measured were similar to levels reported in upstream samples collected in conjunction with preoperational monitoring programs being conducted by TVA at nuclear plant construction sites.